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GRANVILLE, OHIO

BLACK RIVER AND OTHER CEPHALOPODS FROM MINNESOTA, WISCONSIN, MICHIGAN, AND ONTARIO

(PART I)

AUG. F. FOERSTE

Received October 18, 1932; published December 21, 1932

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77. Actinoceras cf. bigsbyi Bronn
78. Actinoceras sp. (Minneapolis)
79. Leurorthoceras husseyi Foerste
80. Deiroceras python (Billings)
81. Deiroceras remotiseptum (Hall)
82. Deiroceras scofieldi Foerste
83. Deiroceras kindlei Foerste
84. Deiroceras paquettense Foerste
85. Deiroceras pertinax (Billings)

E. Actinoceroid, depressed dorsoventrally
86. Gonioceras kayi Foerste
87. Gonioceras occidentale Hall
88. Lambeoceras confertum Foerste
89. Lambeoceras cf. nudum Troedsson

F. Cyrtoconic, circular, siphuncle subcentral
90. Centrocyrtoceras subannulatum (D'Orbigny)
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92. Centrocyrtoceras relaxum Foerste
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94. Centrocyrtoceras bondi (Safford)
95. Centrocyrtoceras vicinum Foerste
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106. Whitfieldoceras trentonense Foerste
107. Whitfieldoceras baffinense Foerste

G. Crytoconic, circular, siphuncle on convex side
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124. Richardsonoceras falx (Billings)
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129. Beloitoceras janesvillense Foerste
130. Beloitoceras huronense (Billings)
131. Beloitoceras houghtoni (Clarke)
132. Beloitoceras norwoodi (Clarke)
133. Beloitoceras carveri (Clarke)
134. Beloitoceras isodorus (Billings)
135. Beloitoceras clochense Foerste
136. Beloitoceras murrayi Foerste
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138. Oncoceras tetreauvillense Foerste
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BARRANDEOCERAS, Gen. nov.

145. Plectoceras robertsoni (Hall)
146. Plectoceras carletonense Foerste

J. Cyrtoconic, depressed, with siphuncle on convex side
147. Ehlersoceras huronense Foerste
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METASPYROCERAS; genotype, Spyroceras ruedemanni Foerste
RASMUSSENOCERAS; genotype, Lambeoceras leveannulatum Troedsson.
PAQUETTOCERAS; genotype, Paquettoceras allumettense Foerste
WHITFIELDOCERAS; genotype, Oncoceras mumiaforme Whitfield
LOGANOCERAS; genotype, Cyrtoceras regulare Billings
KENTLANDOCERAS; genotype, Kentlandoceras schrocki Foerste
LAPHAMOCERAS; genotype, Cyrtoceras tenuistriatum Hall
RICHARDSONOCERAS; genotype, Cyrtoceras simplex Billings
EHLERSOCERAS; genotype, Ehlersoceras huronense Foerste
ROMINGOCERAS; genotype, Romingoceras josephianum Foerste
STAUFFEROCERAS; genotype Cyrtoceras featherstonhaughi Clarke
SCOFIELDOCERAS; genotype, Cyrtoceras shumardi Clarke
FAYETTOCERAS; genotype, Cyrtoceras thompsoni Miller
TEICHERTOCERAS; genotype, Teichertoceras husseyi Foerste

INTRODUCTION

The Ordovician formations of North America were deposited in relatively shallow marine basins, usually far within the borders of the continental block; in other words, their location was epicontinental. While some of these faunas may have existed for long periods in their epicontinental environments, their ultimate origin must be sought in one of the oceans bordering on the continent,—the Atlantic, the Arctic, or the Pacific. Although the border of oceanic waters surrounding this continent was continuous, differences existed in the faunas inhabiting different oceans, and these differences were reflected in the epicontinental faunas having their origin in these different oceanic basins, so that those epicontinental faunas which are of Atlantic origin are distinguishable from those derived from the Arctic or Pacific. Moreover, in an ocean extending as far north and south as the Atlantic, the faunas of the more northern waters were distinguishable from those of the middle or south Atlantic, and similar differences must have existed in the epicontinental faunas derived from different parts of the Atlantic.

For instance, most faunas of the Trenton of Ontario, New York, New Jersey, and Pennsylvania are very different from those of the corresponding parts of the Trenton of Kentucky and Tennessee, the former being of North Atlantic origin, while the latter were derived from more southern parts of the Atlantic, probably entering the Mississippi embayment by waters more or less corresponding to those of the present Gulf of Mexico. Dr. E. O. Ulrich, who long has been interested in the origins of the different Paleozoic faunas, recently has expressed the strong belief that a distinct marine faunal province existed in the North Atlantic region during a considerable part of Paleozoic time, and that the following formations contain faunal elements indicating connection with the North Atlantic: the Lenoir and parts of the Blount division of the Chazyan of Alabama, Tennessee and Virginia; the Little Oak, overlying the Blount, in Alabama; the Chazyan of the Champlain area; the Chambersburg of Virginia, Maryland, and Pennsylvania; the Decorah member of the Black River and the Trenton ranging from Ontario, New York, New Jersey, and Pennsylvania westward to the Upper Mississippi Valley; the corresponding Ordovician deposits of the Baltic provinces; and the typical Stinchar formation of southwestern Scotland, the fauna of whose upper part is strikingly like the fauna of the upper part of the Lenoir member of the Stones River division of the Chazyan in Tennessee and Virginia.

In a similar manner, the typical Richmond of Ohio, Indiana, Kentucky, and the adjacent parts of Tennessee have a distribution suggesting entrance into the Mississippi embayment from the south, while the Fernvale, though typically known only from western Tennessee, northern Arkansas, eastern Missouri, central Oklahoma, parts of Texas, and Illinois, contains faunal elements which suggest a more northern origin.

The Red River formation of southern Manitoba, and its various equivalents in other areas, is an excellent illustration of an epicontinental embayment with Arctic connections. This formation forms part of the Cape Calhoun series of northwestern Greenland and of the adjacent parts of Ellesmereland. It occurs in southwestern Baffin Land, over a wide area northeast of Foxe

Land. It is represented by the Shammattawa and Nelson limestones in the area southwest of the main body of Hudson Bay. In southern Manitoba it has been called the Red River formation by the present writer. In Wyoming it has been called the Big Horn formation, and this name has priority to the others here mentioned. It ranges from Wyoming eastward into the adjacent parts of South Dakota, northwestward into Montana and Idaho, and southward into Colorado, New Mexico, and Utah. Recently a typical species of *Westonoceras* has been found by Prof. Charles E. Decker near the top of the Viola formation near Bromide in south-central Oklahoma. The Viola here is regarded as of Cincinnatian age, and is overlaid by the Fernvale member of the Richmond. The Red River formation and its equivalents is one of the most remarkable of known Paleozoic formations on account of its enormous extension in a north and south direction, its range from northwestern Greenland to south-central Oklahoma equalling more than 3,100 miles, and extending from the most northern fossiliferous areas known in the Arctic to the southern part of the Temperate zone. The most southern outcrop of this Arctic invasion is in the El Paso area, in the extreme western part of Texas.

It is evident that any considerable series of formations in any single area of deposition is not likely to represent an uninterrupted record of deposition. Detailed study soon reveals interruptions or breaks in deposition, above which new faunal elements make their appearance, in numbers corresponding approximately to the length of the period of nondeposition.

Breaks in different areas of deposition are not likely to take place at the same time, or to have the same duration, so that it frequently becomes difficult to correlate beds in adjacent basins, even when the two basins approach each other quite closely, unless somewhere they overlap or interfinger with each other. This difficulty is presented, for example, in attempting to correlate the various subdivisions of the typical Richmond, in Ohio, Indiana, and Kentucky, with the Fernvale of the Mississippi Valley, or with the Maquoketa of Iowa and neighboring states.

This difficulty is further increased by the recurrence of faunas

with similar faunal elements even within the same basin. Such recurrences are noted, for instance, in the late Trenton Catheys and in the Fairmount member of the Maysville division of the Cincinnatian. Such recurrences are likely to occur at each invasion of the same epicontinental basin by faunal elements from the same oceanic source. Where alternate invasions from two distinct portions of an oceanic source take place, an alternation of faunal elements may take place with sufficient distinctness to suggest alternation in the tilting of that part of the continental mass supporting this basin. Dr. E. O. Ulrich, for instance, has called attention to the similarity of the faunas in the Catheys, the Fairmount, and the Arnheim, the latter being of early Richmond age; and also to the contrasting similarity of that part of the Trenton which precedes the Catheys in Tennessee and Kentucky, and of those Cincinnatian faunas which intervene between the Catheys and the Fairview (of the latter of which the Fairmount is a part), and also between the Fairview and the Arnheim. The former group is regarded as having affinities with those parts of the Atlantic whose faunas invaded the Mississippi embayment from the south, while the latter invaded from farther north, possibly from the North Atlantic.

The Lowville member of the Black River group shows a remarkable similarity in its faunal elements over a wide area, extending from New York northward and westward to Lake St. John, 130 miles north of Quebec, to Allumette island and the Lake Timiskaming area along the upper reaches of the Ottawa area, to Lake Nipissing northeast of Georgian Bay, through southern Ontario, the northern peninsula of Michigan, and Wisconsin to Minnesota, and thence southward to Missouri and Tennessee. Its Decorah member extends from Minnesota and Wisconsin southward as far as eastern Missouri and central Kentucky. Its local occurrence and extreme thinness in central Kentucky and its total absence farther south suggest the northern origin of its fauna. Not only the Decorah, but also the Trenton of the Upper Mississippi Valley is regarded as of northern origin, their faunas representing North Atlantic invasions.

One of the problems of immediate interest is the correlation of

the different members of the Red River formation, and its equivalent elsewhere, with the formations exposed farther eastward on the American continent. In my paper on the Cephalopods of the Red River formation of Southern Manitoba I have listed the species recorded from this formation and area and have indicated 54 species as listed, in Bassler's Bibliographic Index of American Ordovician and Silurian Fossils, only from below Cincinnatian horizons, while 13 are listed only from Cincinnatian or Richmond formations, or both. Based on the theory that the preponderant Trenton of Black River elements represented recurrences of earlier faunas, and that the Cincinnatian or Richmond species represented introductions of a later fauna, the weight of evidence was regarded as in favor of the age of the more recent introductions than of the remnants of earlier forms. This led to the interpretation of the Red River as either of Cincinnatian or of Richmond age. As a matter of fact, the Richmond was favored in consequence of the presence of several species of corals and brachiopods regarded as diagnostic of the Richmond.

Those species of corals which suggest the Richmond age of the Red River formation include *Calapoecia canadensis, Columnaria (Palaeophyllum) stokesi, Halysites gracilis,* and *Paleofavosites prolificus.* All of these species are listed by R. C. Hussey from the Bill Creek member of the Richmond formation, on the peninsula between Little and Big Bay de Noc, east of Escanaba, Michigan, the first three of these species being relatively abundant here. The Bill Creek member forms the highest part of the Richmond exposed in this part of northern Michigan, and overlies beds containing typical forms of *Dinorthis subquadrata,* a species not found below the Liberty member of the Richmond in Ohio, Indiana, and Kentucky. Hence, the occurrence of these corals in the Red River formation of southern Manitoba suggested the correlation of the latter with the Richmond.

However, it should be remembered that forms similar to the first three of the corals here cited from the Red River formation, are known already from the Black River formation. Precursors, for instance, were cited by Lawrence M. Lambe from the Black River formation at Blue Point, north of Roberval, on the west

side of Lake St. John, in Quebec, under the names *Calapoecia canadensis, Halysites catenularia* var. *quebecensis,* and *Columnaria rugosa.* The *Calapoecia* is cited also from the Black River of Ottawa, Hull, and the Paquette Rapids, and specimens referred to *Calapoecia* were found by the present writer also in the upper part of the Black River formation as exposed on Cloche island, in the northern part of Lake Huron.

While none of these Black River precursors appear strictly identical with the Richmond forms exposed in the Big Hill member of the Richmond, it is evident that intermediate forms must have occurred somewhere in those formations which intervene between the Black River and the Richmond, and that these intermediate forms are not known at present from any source, unless the Red River represent such an intermediate horizon.

The brachiopods that suggest the Richmond age of the Red River formation include *Dinorthis proavita, Dinorthis subquadrata, Leptaena unicostata, Rhynchotrema anticostiense,* and *Rhynchotrema capax.* All of these species have been identified from the Richmond as exposed in the Upper Mississippi basin. *Dinorthis proavita* and *Leptaena unicostata* were originally described from the Upper Mississippi valley. *Rhynchotrema anticostiense* was originally described from Anticosti, where it occurs in the English Head, Vaureal, and Ellis Bay members of the Richmond. *Dinorthis subquadrata* and *Rhynchotrema capax* are abundantly represented in the Liberty and Whitewater members of the Richmond in Ohio, Indiana, and Kentucky, the latter making its appearance already in the underlying Waynesville member. It is of interest, however, to note that in central Kentucky *Dinorthis subquadrata* is preceded by the closely similar *Dinorthis ulrichi,* which is characteristic of the Flanagan member of the Trenton. Moreover, the writer once found a specimen of *Rhynchotrema,* closely resembling *Rhynchotrema capax* in form and size, south of the west end of Lac Calvaire, 12 miles southwest of the city of Quebec, in black shales apparently as low as the lower Eden of Cincinnatian areas.

These occurrences are cited to indicate the extreme difficulties presented when attempting to correlate strata deposited in dis-

tinct basins by means of fossils believed to be common to both. It is evident that mere general resemblances can lead far astray. Absolute identity of form and structure, even in the smallest details, should be sought.

Another species originally described from the Richmond of the Upper Mississippi Valley is *Onchometopus susae*.

Among the cephalopods suggesting the Richmond age of the Red River formation are *Cyclendoceras whiteavesi*, *Billingsites costulatum*, and *Lambeoceras lambi*. The *Cyclendoceras* is very similar to a species found in the Maquoketa of Iowa, not yet described. The genus *Billingsites* is known at present only from the Richmond, though *Probillingsites* is known also in the Trenton. The only species of *Lambeoceras* known in strata not belonging to the Arctic invasion including the Red River, Big Horn, Cape Calhoun, or other equivalent beds, is the *Lambeoceras richmondense*, described from the Whitewater member of the Richmond in Indiana. However, if close similarity between species occurring in distinct basins is likely to lead to incorrect correlation, it is evident that mere generic relationship is still less satisfactory. Strict identity of stratigraphic units requires strict identity of the diagnostic specific forms.

In 1930, Edwin Kirk called attention to the presence of *Cryptolithus* in areas also showing exposures of the Big Horn formation. In the Eureka district of central Nevada, this *Cryptolithus* zone overlies an horizon which is either of lower Big Horn age or is younger. In the Marathon basin, 200 miles southeast of El Paso, Texas, *Cryptolithus* occurs in a series of limestones carrying a fauna of later age than the lower Big Horn, but underlaid by a conglomerate in which lower Big Horn fossils were present. On the basis of these occurrences of *Cryptolithus*, Kirk regards the lower Big Horn as at least older than the Maysville. While admitting the possibility of its age being even as old as that of the Trenton, he evidently favors provisionally its Cincinnatian age.

Recently a typical species of *Westonoceras* was found by Prof. Charles E. Decker at two localities in the vicinity of Bromide, in south-central Oklahoma, near the top of the Viola limestone, and a short distance beneath the Fernvale member of the Richmond.

Since *Westonoceras* is regarded at present as a genus characteristic of the Arctic invasion which includes not only the Red River formation, but also the Big Horn and various other formations, all evidently approximately equivalent, this indicates that these formations, or at least their lower parts are older than the Fernvale. This was indicated already by Kirk in 1925. An interesting feature of this Oklahoma occurrence of *Westonoceras* is its association here with *Cryptolithus*.

East of the Mississippi River the latest representative of the genus *Cryptolithus* is the species *Cryptolithus lorrainensis*, described by Ruedemann, from the lower half of the Sandy Creek member of the Pulaski division of the Lorraine group of strata. These Sandy Creek beds are correlated provisionally with the lower half of the Belleview member of the Fairview division of the Maysville.

Assuming that the genus *Cryptolithus* became extinct in America before the close of the Maysville, it is evident that at least the Lower Big Horn can not be younger than that formation. In other words, it must be pre-Richmond.

However, it is not yet certain that this conclusion is necessary. The Richmond contains many species whose precursors are found in the Trenton and even in the Black River. The exact affinities of the western species of *Cryptolithus* have not yet been determined. Therefore, for the present, the possibility can not be excluded that *Cryptolithus* continued its existence until post-Maysville times. Whether this will require the correlation of the Red River and Big Horn formations with the Richmond is another question. Possibly they are younger than typical Maysville and older than typical Richmond. Only a more detailed study of their faunas can offer a solution.

It is hoped that a more intensive study of the Upper Ordovician formations in the western part of the Mississippi Valley may eventually reveal more definite correlations for the different zones present in the Red River, Big Horn, and other western formations of Arctic origin.

For instance, two of the cephalopods described by Clarke from the Stewartsville formation in Minnesota suggest the northern

origin of the fauna of this formation. One of these was identified by Clarke with *Lambeoceras lambi* (Whiteaves), but here is defined as a new species, *Lambeoceras confertum*. The other species was described by Clarke as *Oncoceras minnesotense*, but later was referred by me to the recently erected genus *Westonoceras*.

Diestoceras staufferi, with an aperture similar to that of *Diestoceras whiteavesi* Foerste, was found in the Wykoff beds of Sardeson, included by Harry S. Ladd in the upper part of the Elgin member of the Maquoketa, in Fillmore county, in southeastern Minnesota.

Recently Prof. R. C. Hussey collected from the Trenton, near Cornell, 12 miles northwest of Escanaba, Michigan the cephalopods here described as *Probillingsites sp.*, *Teichertoceras husseyi*, and *Westonoceras cornellense*.

Probillingsites makes its appearance already in the Trenton and continues as far as the lower part of the Richmond, while *Billingsites* is known at present only from the Richmond. The genus *Teichertoceras* closely resembles *Westonoceras* in general form and structure, differing chiefly in the location of the siphuncle on the concave side of the conch, instead of its convex side. While the specimens from the Stewartville of Minnesota and the Trenton of Michigan identified as *Westonoceras* closely resemble the lower parts of the conchs of that genus, it should be remembered that the most characteristic features of this genus are presented by the parts farther up. For instance, along the upper part of the phragmacone of typical *Westonoceras* the sutures of the septa rise strongly ventrally, and the ventral outline of the conch is conspicuously humped at a level 4 or 5 camerae beneath the base of the living chamber. Above this hump the conch contracts strongly toward the aperture. Until these more characteristic features are discovered also in conchs derived from the Stewartville of Minnesota or the Trenton of Michigan, the identification of the conchs in question as *Westonoceras* can not be said to be fully established.

One of the difficulties in correlating the Red River, Big Horn, and other equivalent formations with strata in New York state or in the Ohio Valley, is the uncertainty as to the exact stratigraph-

ical position of some of the Upper Ordovician formations of the Upper Mississippi valley with reference to these more eastern sections of the North American continent. For instance, in his paper on the Telephidae, published in 1929, Dr. E. O. Ulrich tentatively correlates not only the Viola of Oklahoma but also the Galena of the Upper Mississippi valley with the Eden and Maysville divisions of the Cincinnatian. Even if the Trenton age of the Galena be granted, there still remains the problem of the exact age of the Stewartville, and of the Dubuque. Finally, although the Fernvale of the more southern parts of the Mississippi valley appears to belong to the lower part of the Richmond, it still remains to determine the exact stratigraphical equivalence of those Richmond formations which are exposed farther northward, in Wisconsin, Michigan, Minnesota, and Iowa. It is evident that a clearer understanding of these more northern exposures of the Mississippi valley will be of great assistance in correlating the various divisions of the Red River, Big Horn, and equivalent formations in more western areas, especially in view of the fact that these more northern exposures of the Mississippi valley appear also to be of northern origin, and to be more nearly related to the Red River and Big Horn formations than are the typical Richmond horizons of the Ohio valley.

COLOR PATTERNS OF FOSSIL CEPHALOPODS

In a paper on the *Color Patterns of Fossil Cephalopods,* published in the Contributions from the Museum of Paleontology of the University of Michigan, in 1890, I summarized existing knowledge on this subject. In this paper Stuart Weller's illustration of a cephalopod identified as *Orthoceras tenuistriatum* (Hall), with vertical color bands (Palaeozoic Faunas, Geol. Surv. New Jersey, pl. 13, fig. 1, (1903), was overlooked.

In the present paper vertical color banding is noted in *Orthoceras huronense, Orthoceras josephianum, Orthoceras romingeri, Orthoceras shideleri, Geisonoceras scofieldi,* and *Sactoceras pictolineatum.* Vertical grooves on the surface of the shell, suggesting the former presence of vertical color bands, occur in *Ormoceras hitzi,* and *Deiroceras pertinax.* Numerous short transverse color

lines, arranged in diagonally crossing series, occur in *Oncoceras casei*. One side of the holotype of *Kionoceras multistriatum* presents dark transverse bands within the camerae, immediately beneath the ventral side of the septa, evidently due to darker material within the matrix at these levels, and not to coloring within the shell substance itself.

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It is evident that the studies here recorded could not have been undertaken without the liberal loan of types and other specimens from numerous collections. I am specially indebted to Prof. C. R. Stauffer for the loan of those cephalopods originally described by John M. Clarke in the Geology of Minnesota; to Professors George M. Ehlers, and R. C. Hussey for collections in the museums of the University of Michigan; to Dr. E. M. Kindle and Dr. Alice E. Wilson for the loan of specimens from various parts of southern Ontario; to Dr. Chester A. Reeds for the loan of types from the American Museum of Natural History; and to Dr. R. S. Bassler and Dr. E. O. Ulrich for the privilege of studying the specimens in the U. S. National Museum, and for frequent assistance in stratigraphical and other problems arising during the progress of this work. To all of these I here express my sincere appreciation of the assistance rendered.

ENDOCERAS Hall

Genotype.—*Endoceras proteiforme* Hall, Pal. New York, *1*, 58, 207 footnote, 208, pl. 48, fig. 4; pl. 49, figs. 1 a–e (1847).

The species first described in the Paleontology of New York is *Endoceras subcentrale* Hall, from the Watertown member of the Black River formation at Watertown, New York. Since none of the Black River species referred by Hall to *Endoceras* is sufficiently well known to serve as a good genotype, Bassler, in his Bibliographic Index of American Ordovician and Silurian Fossils, has selected *Endoceras proteiforme* as such a type, and this selection has been followed since.

The chief characteristic of this genus appears to be its relatively large siphuncle, very close to the ventral wall of the conch and

probably in contact with the latter in many species; the endocones are long and gradually tapering, with rounded cross-sections, not annulated obliquely.

Orthoceras rapax Billings here is referred to *Endoceras* chiefly because its siphuncle is described as large and marginal. However, in the absence of any knowledge of the structure of this siphuncle there is a possibility that this generic reference is altogether in error, and that its real relationship is with some form of the Actinoceratidae, for instance, *Armenoceras,* in which the siphuncle also may be large and marginal. A corresponding error was made by the writer in connection with a specimen from Great Slave Lake (Jour. Sci. Lab., Denison Univ., 24, 206, pl. 25, fig. 3, (1929)), which he described as an *Endoceras,* but which, on sectioning, turned out to be an *Armenoceras.*

1. **Endoceras** (?) **rapax** (Billings)

Plate 7, fig. 3

Orthoceras rapax Billings, Canadian Naturalist and Geologist, *5,* 176 (1860).

The original description is as follows:

> Large, section circular, septa distant a little less than one-fourth of an inch where the diameter is between five and six inches. Siphuncle large, marginal, very nearly in contact with the shell on the ventral side. The rate of tapering appears to be about one inch and a half to the foot. The depth of the chamber of habitation is about one-half greater than the width of the aperture.
>
> Of this species we have portions of two individuals. One is a fragment of the oral extremity entirely deprived of the shell, and exhibiting a good cast of the interior of the chamber of habitation. The following are the dimensions. Length fourteen inches; diameter at aperture six and a half inches; at fourteen inches from aperture, four and three fourths inches; diameter of siphuncle one inch and three fourths at the broken or smaller end of the specimen; the first twenty-one septa occupy a length of four inches and seven eights.
>
> The second specimen is fifteen inches and a half in length, and tapers from 6 inches to four as nearly as can be determined. In the first five inches of the smaller extremity there are twenty septa; in the next inch, five; in the next inch and a half twelve; and in the remainder from four to seven in the inch.
>
> The distance of the septa is thus variable in the same specimen, but, judging from the general appearance of the two examined, my present impression is that the average distance must be from two and a half lines to three lines, or a little less than one-fourth of an inch at a diameter of from four to six inches. The

proportional distance of the septa to the diameter of the shell therefore would be about as twenty to one.

This specimen clearly belongs to the same group as those which Professor Hall has figured under the name of *Endoceras proteiforme*, in the 1st Vol. of the Palaeontology of New York. But on measuring the figures in that work it will be seen that the proportional distance of the septa to the diameter of the shell in that species is between four and eight to one, or six to one on an average, while in this species it is twenty to one.

Locality and Formation.—The specimens were secured at Kingston in the Black River limestone.

The specimen retaining the siphuncle appears lost. However, the following one, obtained at the same locality, evidently belongs to the same species, and may be regarded as a topotype.

Specimen 185 mm. long; preserved for a width of 128 mm. at its base, but its original diameter at this point is estimated at approximately 135 mm. Its rate of enlargement can not be determined with accuracy. Twenty camerae occupy a length of 110 mm. along the lower end of the specimen, but these vary irregularly in length, from 3 camerae in a length of 20 mm. to 3 in a length of 13 mm. Evidently there were stages of retardation of growth alternating with stages of more normal growth. One of these stages of retardation occupies a length of 18 mm. above the well exposed septum at the base of the specimen; another begins 100 mm. above this septum and continues for a length of about 30 mm. The concavity of this septum is 25 mm. The sutures of the septa are directly transverse. No trace of the siphuncle is preserved. Evidently it is the dorsal half of the conch which is retained in the specimen at hand. This is labelled as coming from Kingston, Ontario, Canada; from the Black River formation, and as collected by Col. R. A. Gordon. Topotype; no. 1355, National Museum of Canada.

CAMEROCERAS Conrad

Genotype.—*Cameroceras trentonense* Conrad, Jour. Acad. Nat. Sci. Philadelphia, *8*, 267 (1842); Hall, Pal. New York, *1*, 221, pl. 56, figs. 4 a, b, c (1847); Foerste, Jour. Sci. Lab., Denison Univ., *20*, 212, pl. 24, figs. 1–5 (1924).

The genotype presents the following features. Conch compressed laterally, the dorsal side of its cross-section slightly more

narrowly rounded, the compression possibly due to pressure after the death of the animal. Sutures of septa directly transverse, curving slightly downward laterally, this downward curvature probably not a constant feature in the genus. Siphuncle in contact with the ventral wall of the conch along a width of 3 or 4 mm., this side of the siphuncle not showing the oblique annulations characteristic of the remainder of the siphuncle. The septal necks are one camera in length. They contract within the upper half of the camerae, expand within the lower half, and then contract again toward their lower margin so as to admit of insertion of this margin into the top of the septal neck next beneath. The endocones are much shorter than in typical *Endoceras*, and they differ from those of the latter genus also in being obliquely annulated, these oblique annulations sloping in approximately the same direction as the annulations on the siphuncle and the course of the adjacent parts of the septa.

Present knowledge of the genus is not satisfactory, and additional material is needed for further study. Wherever the endocones are preserved, the species having short, obliquely annulated endocones are referred at present to *Cameroceras*. The apical ends of *Cameroceras* probably also are distinguishable from those of *Endoceras*, but apical ends definitely referable to identifiable species of either genus are extremely rare.

The reference of *Orthoceras multicameratum* Emmons to *Cameroceras* is based merely upon the small size of its siphuncle. It may prove to belong to an entirely distinct generic group when the structure of its siphuncle is more definitely known.

2. **Cameroceras** (?) **multicameratum** (Emmons)

Plate 8, figs. 1, 2, 3; pl. 9, fig. 1

Orthoceras multicameratum Emmons, Nat. Hist. New York, 2nd. Dist., 382, fig. 93 (1842); Hall, Pal. New York, *1*, 45, pl. 11, figs. 1 a–c (1847).

Original of Hall's figure 1.—Length 310 mm. Of this length at least 210 mm. belongs to the phragmacone, the living chamber being approximately 100 mm. in length. The lateral diameter enlarges from 20 mm. near the base of the phragmacone to 40 mm.

at a point 130 mm. farther up, and to 55 mm. after an additional interval of 130 mm. This indicates an angle of enlargement of the conch of 8 degrees along most of the phragmacone, decreasing to 6 degrees at the top of the phragmacone and along the living chamber. Near the top of the phragmacone, where its lateral diameter is 46.5 mm., its dorsoventral diameter is estimated at 43 mm. Either the conch originally was slightly depressed dorsoventrally or it flattened slightly in that direction after the conch was imbedded in its matrix. At diameters of 25 and 30 mm. the number of camerae in a corresponding length immediately beneath is almost 9. At a diameter of 37 mm. this number of camerae equals 12, and at the top of the phragmacone, where the diameter is about 46 mm., the number of camerae appears to equal 14, although at this uppermost level some of the camerae are not delineated clearly. The sutures of the septa slope downward in a ventrad direction at an angle of 15 degrees with a horizontal or directly transverse plane. Where the lateral diameter of the conch is 30 mm., that of the siphuncle is either 7 mm. or 7.5 mm., and its distance from the ventral wall of the conch is 3.5 mm. Where this lateral diameter of the conch is 40 mm., that of the siphuncle is 8 mm. and its distance from the ventral wall of the conch is at least 4.5 mm. Corresponding to their sutures, the septa slope downward in a ventrad direction from their dorsal outline as far as the dorsal side of the siphuncle, from which they rise toward their ventral outlines. The result is that their deepest concavity lies ventrad of the center of the conch. The structure of the siphuncle appears holochoanoidal, the septa curving downward at the top of the septal neck, the latter continuing vertically downward for the length of one camera, and then invaginating into the top of the next underlying septal neck for a length of almost one millimeter. Along the annular area of contact between the top of one septal neck and the bottom of the overlying invaginating one the total thickness of the double wall formed by these two necks occasionally exceeds the sum of the thicknesses of these two necks when measured separately immediately above and below this contact area. The living chamber of this specimen contains numerous fragments of *Te-*

tradium cellulosum Hall. One of several specimens numbered 581, in the American Museum of Natural History. Plate 8, figs. 1, 2, 3.

The specimen is distinctly curved lengthwise, with its ventral outline convex. This is contrary to the direction of curvature found in typical Holochoanoidea. There is a possibility of its original form having been straight, the curvature being due to distortion, after the death of the animal.

Original of Hall's figure 1c.—Specimen 136 mm. long, enlarging at approximately the same angle laterally as the preceding specimen. Only a weathered transverse vertical section exposing the siphuncle along almost its entire length is shown distinctly. Along this section the lateral diameter of the specimen increases from 9 mm. at its base to 28 mm. at its top. However, the cross-section at the top of the specimen presents a lenticular appearance, at least on its right side, and here the lateral diameter equals at least 30 mm. Whether this lenticular cross-section is natural or the result of compression can not be determined from the specimen at hand. Since the exterior of the conch is not exposed, the direction of the sutures of its septa can not be determined. The ratio between the diameter and the number of camerae in a corresponsing length immediately beneath is indicated by the following data: At a diameter of 12 mm. there are 6.5 camerae; at 13.5 mm. there are 7 camerae; at 15 mm. there are 8 camerae; at 19.5 mm. there are 8 camerae; at 23.5 mm. there are 11 camerae; and at 27 mm. there are 12 camerae. The vertical sections of the septa show remarkably little concave curvature, their outlines being almost straight, as in the species figured by Hall on the same plate and from the same horizon as *Orthoceras recticameratum*. Where the diameter of the conch is 20 mm. that of the siphuncle is 5 mm. In the immediate vicinity of the siphuncle the septa curve along a width of about 1 mm., and then, for a length of one camera, the septal necks curve slightly inward, so as to appear slightly constricted within the camerae. The matrix contains fragments of *Tetradium cellulosum*. Specimen number 12385 in the New York State Museum, at Albany. Plate 9, fig. 1.

In this specimen the ratio of the diameter of the siphuncle to that of the conch is essentially the same as in the preceding specimen. The structure of the siphuncle also is similar, excepting that the segments of the siphuncle are gently concave within the camerae, instead of straight. The course of the septa between the lateral margins of the conch and the siphuncle is relatively straighter. Where the diameter of the conch is 20 mm., there are 11, instead of 9 camerae, within a corresponding length. At the base of the specimen the camerae appear relatively crowded. Unfortunately it is impossible to determine with confidence the exact cross-section of the conch, and the relative distance of the siphuncle from the ventral wall of the conch. However, in the present state of knowledge regarding these two individuals, they may be regarded as belonging to the same species. If distinct, it will require additional material to establish that fact.

The original of Hall's figure 1b can no longer be found. It evidently was closely similar to that represented by his figure 1.

Original of Hall's figure 1a.—the specimen labelled as the original of Hall's figure 1a resembles this figure in its rate of enlargement, in the size attained at its larger end, and in the relative number of camerae present in a length equal to its diameter where the latter is about 8 or 10 mm. However, its preservation is far inferior to that indicated by the figure published. The conch enlarges at an angle of about 5 degrees. The specimen is exposed for a length of 113 mm. At its top its diameter is 17 mm. At 100 mm. farther down its diameter is about 8 mm. The conch can be traced for an additional length of 13 mm. farther down, but below this level, for a length of 18 mm., it apparently is absent. At least, no trace remains along the lower margin of the rock forming the matrix. At a diameter of 8 or 10 mm. the number of camerae in a corresponding length equals 3; at 12 mm. there are 3.5 camerae, and at a diameter of 16 mm. there are 5.5 camerae. The break in the specimen as figured by Hall is indicated at the point where the original fails to show any further exposure in an apicad direction. The lower part of Hall's figure may be entirely imaginary. The matrix contains numerous fragments of *Tetradium cellulosum*, also a poorly preserved valve of some species

of *Modiolopsis*. The specimen belongs to a group numbered 581 in the American Museum of Natural History.

This specimen differs from the original of Hall's figure 1c in its smaller angle of enlargement and in the relatively smaller number of its camerae within a length equal to the diameter of the conch, their number equalling 3.5 at a diameter of 11 mm., where in the original of Hall's figure 1c there are 6 camerae. It differs in similar respects, though to a lesser degree, with the original of Hall's figure 1. However, in the absence of any knowledge of the location of its siphuncle, or of the structure of the latter, it appears advisable to regard its relationship to the latter as uncertain.

Occurrence.—Watertown, New York; in the Lowville member of the Black River formation.

Remarks.—The structure of the siphuncle in the second specimen here figured and described (pl. 9, fig. 1) is not as clearly defined as desirable, and further information is needed before this structure can be regarded as sufficiently known for definite generic reference.

NANNO Clarke

Genotype.—*Nanno aulema* Clarke, Amer. Geol., *15*, 207, pl. 6, figs. 1–8; Hyatt, Amer. Geol., *16*, 1–11, pl. 1, figs. 1–4 (1895); Clarke, Geol. Minnesota, *3*, pt. 2, 770, pl. 47, figs. 4–11 (1897).

The genotype preserves a preseptal cone continuing upward as the siphuncle. The ventral outline of this combination is slightly but distinctly convex. The preseptal cone is about 10 mm. long along its dorsal outline and then contracts strongly in the following 5 or 6 mm. toward the cylindrical part of the siphuncle. There is no trace of oblique annulation along the preseptal cone. The first camera occurred where the dorsal contraction of the preseptal cone begins, the conch evidently continuing to expand rapidly in a dorsoventral direction for a distance of 30 mm. from its apical end, above which the rate of enlargement of the conch apparently was considerably less, though only the impression of the conch remains here.

The structure of this genotype apparently conforms with that

of the apical end of *Endoceras*. However, so little is known of the apical ends of American species of this genus that it seems inadvisable at present to assert the generic identity of *Nanno* with *Endoceras*. Since *Endoceras* was founded on American species, and not on those of the Baltic areas of Europe, it seems preferable to wait until the apical ends of American species definitely referable to typical *Endoceras* are clearly understood.

3. **Nanno aulema** Clarke

Plate 32, figure 14

Nanno aulema Clarke, Geol. Minnesota, *3*, pt. 2, 770, pl. 47, figs. 4–11 (1897).

The original of Clarke's figure 6, cited above, is 60 mm. long. The preseptal cone is faintly concave along its ventral outline, the first septum being 16.5 mm. above its narrowly rounded base. Its dorsal outline is faintly convex for a length of 8 mm. and then curves convexly upward and inward, reaching the first septum between 10 and 12 mm. above its base. At this point the preseptal cone reaches a maximum dorsoventral diameter of 8 mm., becomes enclosed by the camerae, except along the median part of its ventral side, and then narrows into the continuation known as the siphuncle. Between 23 and 33 mm. above the base of the specimen the diameter of this siphuncle is 6.5 mm. Then it curves in a dorsad direction to a point 37 mm. above its base and becomes erect again, narrowing to a dorsoventral diameter of 5.3 mm. at 40 mm. above its base. Above this, the siphuncle remains small and erect for an additional distance of 15 mm. The ventral side of the siphuncle evidently is in contact with the adjacent wall of the conch for a width of at least 3 mm. at its lower end, this width possibly narrowing a little farther up. Two camerae are preserved fairly well ventrolaterally, their limiting septa being respectively at 15, 18, and 21.5 mm. above the base of the specimen, when measured along the median part of its lateral side. A third camera, directly overlying the other two, is a little shorter, and has a dorsoventral diameter of 16.5 mm. at a point 24 mm. above the base; 6 mm. farther up this diameter is at least 19 mm.

Evidently the conch enlarges considerably on its dorsal side before becoming strictly erect. The three camerae mentioned are the second, third, and fourth of the series. The first camera is not preserved, but there is a vacant space where it formerly existed. The preseptal cone is not obliquely annulated. The surface of the siphuncle is annulated parallel to the course of the adjacent part of the septa, these annulations sloping downward in a dorsad direction at an angle of 25 degrees with the horizontal. The flexure in the siphuncle between 33 and 37 mm. above its base probably is abnormal, but this can not be determined from the single specimen at hand.

This specimen is accompanied by free apical ends of other siphuncles, including the preseptal cone, one of which includes the original of Clarke's figures 7 to 9, cited above. The latter are also included by Clarke in his *Nanno aulema*, but their preseptal cones are much longer than in the camerated specimen here selected as the type.

Occurrence.—Minneapolis, Minnesota; from the Decorah member of the Black River. No. 48198, U. S. National Museum.

ORTHOCERAS Blainville

Genotype.—*Orthoceras regulare* Schlotheim, Die Petrefactenkunde, 54 (1920); Troedsson, Studies on Baltic Fossil Cephalopods, No. 1, On the Nautiloid Genus *Orthoceras* (1931); No. 2. Vertically striated or fluted orthoceracones in the Orthoceras limestone, 31 (1932); Blainville, Manuel de malacologie et de conchyliologie, 379 (1825).

For a full discussion of the relative merits of different terms, such as *Orthocera*, *Orthoceratites*, and *Orthoceras*, the reader is referred to the detailed discussion presented by Troedsson in the publication cited above.

The chief characteristics of the genotype, *Orthoceras regulare* Schlotheim, are there fully discussed, and are here repeated in sufficient detail to indicate that no representative of this genus in known in America.

Conch slowly expanding, the apical angle about 2 or 3 degrees. The largest living chamber found has a diameter of 40 mm. and

from this it is estimated that the total length of the conch may have been 1.2 meters. The relative length of the living chamber compared with its maximum diameter is about as five to one, but it varies considerably in different specimens. The most characteristic feature of this species is the presence of three distinct vertical impressions or grooves near mid-length of the living chamber, with corresponding grooves on the cast of the interior of the shell. One of these grooves is along the median part of the dorsal side, and the two others are located on the ventrolateral margins of the chamber. The dorsal groove usually is longer than the ventrolateral ones. The length of these grooves varies from less than 10 mm. to longer than 25 mm., and their depth from 1 to 7 mm. Since the depth of these grooves often is greater on the cast of the interior of the conch than on the exterior of the shell, it is evident that the inner surface of the shell tends to be thickened here. Evidently these grooves and the corresponding narrowing of the interior of the living chamber may have had a utility in facilitating the attachment of the animal to the conch. A similar use may be ascribed to the annular thickening of the interior of the shell toward the aperture of numerous orthoconic nautiloids, which often show no evidence of this thickening exteriorly, but which leave in its place a more or less deep and broad impression on the upper part of the casts of their living chambers. The sutures of the septa are directly transverse. The location of the siphuncle is nearly central. The camerae are about half as high as their diameter, shortening somewhat close to the living chamber. The sutures are straight and directly transverse. The diameter of the siphuncle is one-sixth or one-seventh of that of the conch. It contracts only slightly at the septal necks. These necks are short and their lower parts are directed vertically downward. The surface of the shell is distinctly ornamented by numerous relatively narrow transverse lines, and more numerous and less readily detected vertical ones.

No species with vertical gooves near or above mid-length of the living chambers are known from American strata. If the presence of these grooves be considered a diagnostic feature of *Orthoceras*, in its restricted sense, then another designation must be sought

for the species in which the siphuncle is similar in its tubular form, and in which the camerae are similarly elongated vertically, but in which no grooves are present. For these the term *Michelinoceras* here is proposed, with *Orthoceras michelini* Barrande as the genotype. Among American species, *Orthoceras clarkesvillense* Foerste apparently belong here.

In the present paper the term *Orthoceras* is not used in its restricted sense but is applied to any orthoconic conch with relatively small and nearly central siphuncle, with apparently smooth surface of shell, whose relationship to any other group can not be determined definitely.

4. **Orthoceras huronense** Billings

Plate 10, figs. 3A, B

Orthoceras huronense Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, 337 (1857).

Specimen 110 mm. long, 40 mm. of this length belonging to the living chamber; enlarging from a diameter of 8 mm. at its base to 17.3 mm. at the base of the living chamber, and to 19.7 mm. at a point 26 mm. above the latter. At 29 mm. above the base of the living chamber the cast of the interior of the conch contracts slightly along its dorsal side, probably owing to a thickening of the interior of the shell above this level by an annular calcareous deposit extending to, or almost to the aperture. At the base of the living chamber its dorsoventral diameter is 17 mm., the original form of the cross-section probably having been circular. At the base of the specimen 5 camerae occur in a length equal to the diameter of the conch. Where its diameter is 11.3 mm., nearly 4.5 camerae occur in a corresponding length. Immediately below a diameter of 14 mm., 4 camerae occur in a corresponding length; and at the top of the phragmacone 4.5 camerae occur in a length of 17 mm. The uppermost camera is only 1.1 mm. long, the 2 immediately beneath totalling 7 mm. Evidently the conch was fully mature. The sutures of the septa are directly transverse. The location of the siphuncle is central, and its passage through the septum at the base of the specimen is half a millimeter in diameter. Along the ventral side of the living chamber

there are 7 vertical color bands occupying a total area 14 mm. in width where the circumference of the conch is estimated at 56.6 mm.; therefore the ratio of the color banded area to the total circumference is as 1 to 4. However, there is a possibility that an additional color band originally existed on each side of the area within which the color bands at present are distinct. The width of these color bands varies between 0.3 and 0.6 mm.

Occurrence.—Northeast side of St. Joseph Island; Lake Huron, Ontario, Canada; in the Black River Formation. No. 1724, in the National Museum of Canada.

Remarks.—This is not the specimen described by Billings. The latter was described as 6 inches long, and its surface apparently was sulcated with shallow longitudinal furrows, one line in width, which had left their impression on the cast. In the absence of this original specimen, the one described is regarded as a topotype. In the absence of any definite knowledge of the surface of the shell, it can not be asserted definitely whether its surface was smooth, or striated transversely.

In the absence of any knowledge of the structure of the siphuncle no definite reference of this species to any of the more recently established genera can be made.

Compared with the topotype, the original type evidently was longer. The statement that the surface of the specimen appears to have been sulcated with shallow longitudinal furrows, one line in width, which have left their impression on the cast, suggests the original presence of color-bands, the areas between these color-bands usually weathering more readily than the bands themselves in color-banded orthoconic cephalopods. This type, forming the basis of the original description by Billings, appears to be lost.

5. **Orthoceras josephianum** Sp. nov.

Plate 10, figs. 2A, B

Specimen 40 mm. long, enlarging from a diameter of 5.5 mm. at its base to 9 mm. at its top, its apical angle being 6 degrees. The living chamber appears to be 17 mm. long. At this distance from the aperture there is a trace of a suture, with another 1.6

mm. farther down. No other sutures are distinctly outlined. Along the lower 16 mm. of its length the shell is preserved along its ventral side. Here the median part of the ventral side is ornamented by 7 light brown vertical color bands, which occupy an area 5 mm. wide where the circumference of the conch is estimated at 22.5 mm., so that the width of this color banded area equals about two-ninths of the circumference. The color bands are about one-sixth or one-seventh of a millimeter wide and are separated by intervals of about half a millimeter. Exterior to this color-banded area the shell is preserved sufficiently well to preserve additional color bands if any originally were present, but none can be detected. The siphuncle is not preserved.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype, no 14417, in the museum of the University of Michigan.

Remarks.—This specimen is characterized by its slender proportions and relatively long living chamber.

6. **Orthoceras romingeri** Sp. nov.

Plate 10, figs. 6A, B; 7

Specimen 77 mm. long, enlarging laterally from a diameter of 10 mm. at its base to 17 mm. at a point 55 mm. farther up, its apical angle being 8 degrees. The corresponding dorsoventral diameters are 9 mm. and approximately 15.5 mm. The uppermost clearly defined septum is 38 mm. beneath the aperture of the living chamber. Where the diameter of the conch is 13 mm. 7 camerae occupy a corresponding length. The sutures of the septa are directly transverse. The location of the siphuncle is slightly ventrad of the center of the conch. The thickness of the shell is between one-fifth and one-fourth of a millimeter. Its surface is smooth, with traces of very minute transverse lines, scarcely visible even under a lens. In addition the shell is vertically color-banded, the color-banded area occupying a width of 13 mm. where the circumference of the conch is 46 mm., which is equivalent to two-sevenths of this circumference. There are 5 of these vertical color bands. Their color is a reddish brown. Their width varies from 1.8 mm. to 2 mm. and the intervals between

them from 0.8 mm. to 1.0 mm. In addition, the surface of the cast of the interior of the conch is blackened immediately above the sutures of the septa, along the color-banded part of the conch, for vertical widths of half a millimeter to almost an entire millimeter. These transverse color bands apparently are confined to the median and left parts of the color-banded area and extend 3 or 4 mm. to the left of the latter. Apparently they are visible through the semi-translucent shell of the conch, since the latter also appears darkened. Plate 10, figs. 6A, B.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype, no. 14420, in the museum of the University of Michigan. This is the specimen cited by Rominger in his Palaeozoic Rocks of Michigan (Geol. Surv. Michigan, *1*, pt. 3, 66, (1873)), from St. Joseph Island, as similar to *Orthoceras multicameratum*, but with reddish brown longitudinal stripes.

Remarks.—In a second specimen (14422), 59 mm. long, the conch is 16.5 mm. in diameter at the base of the living chamber. Eight camerae occur in a length equal to the diameter of the conch near the top of the phragmacone. In a third specimen (2020A), 29 mm. long and 14.5 mm. in diameter at its top, 9 camerae occur in a corresponding length. The concavity of its septa is 2.2 mm. The center of the siphuncle is located 6.2 mm. from the nearest wall of the conch. Its segments enlarge from 1 mm. at their septal necks to 1.5 mm. at mid-height within the camerae, their general outline being elliptical, with their longer axis in a vertical direction, the top and bottom of their vertical outlines being truncated. The original of figure 7 on plate 10 is numbered 14421.

7. **Orthoceras shideleri** Sp. nov.

Plate 29, fig. 3

Specimen 30 mm. long, its lateral diameter enlarging from 8.5 mm. near its base to 12 mm. at a point 25 mm. farther up. No trace of septa or sutures remains. That side which is faintly grooved in a vertical direction is assumed to be ventral. The opposite or dorsal side is straight lengthwise. Laterally and ventrally the conch appears to contract toward its lower end, appar-

ently due to deformation here. In its present condition the conch enlarges at an angle of 8 degrees at its lower end, decreasing to 5.5 degrees farther up. Where its lateral diameter is 12 mm., its dorso-ventral one is 11.5 mm. The ventral outline is slightly convex, possibly owing to the deformation mentioned above. Twelve vertical, very shallow, grooves occupy the width of 8 mm. along the ventral side of the conch. These grooves, and the intermediate smooth parts of the shell, are approximately of equal width. It is assumed that these grooves formerly were occupied by shell material colored differently from the remainder of the shell, and that this colored part of the shell weathered away more readily, thus leaving the grooves. This is a common feature in conchs known to be vertically color-banded.

Occurrence.—Five miles west of Oxford, Ohio, on Dodges creek; in the Saluda division of the Whitewater member of the Richmond formation. Collected by Prof. W. H. Shideler.

8. **Orthoceras ontarioense** Sp. nov.

Plate 10, figs. 4A, B

Fragment 27 mm. long, apparently belonging to a living chamber, and possibly including its entire length. One outline is faintly convex, the convexity equally 0.5 mm. at midlength. Its diameter increases from 5 mm. at its base to 6 mm. at midlength and then continues without change to the top of the specimen. Its cross-section is circular. The concavity of the septum at its base equals 2.25 mm., which is very considerable, considering the small diameter of the conch at this point.

A second fragment, 8 mm. in length along its lateral walls, has a diameter of 6 mm. at midlength. The septum at its base has a concavity of 3 mm., so that the total length of the specimen is 11 mm. The location of the siphuncle appears to be central and its passage through the septum at the top of the specimen appears to be 0.5 mm. in diameter. The distance between the septa at the top and bottom of the specimen is 8 mm. Grinding away part of one of the lateral sides failed to reveal any additional septa, but the intermediate part was crystalline, and

therefore it is not known with certainty whether originally there were intermediate septa or not.

Occurrence.—Paquette Rapid, at Allumette island on the Ottawa river; in the Leray member of the Black River. No. 6826 in the National Museum of Canada.

Remarks.—These specimens are remarkable chiefly for their small size and for the considerable concavity of their septa.

9. **Orthoceras beltrami** Clarke

Plate 35, fig. 6

Orthoceras beltrami Clarke, Geol. Minnesota, *3*, pt. 2, 789, pl. 55, fig. 10 (1897).

Specimen 31 mm. long, enlarging from a diameter of 2.1 mm. at its base to 3.2 mm. at a point 28 mm. farther up. Ten millimeters of its length belongs to the living chamber, the total length of this chamber being unknown. At the top of the phragmacone 2 camerae occur in a length equal to the diameter of the conch. Along the lower part of the specimen the camerae tend to be relatively a little longer, so that 2 camerae occupy a little more length than the corresponding diameter of the conch. Nothing is known of the siphuncle, or of the concavity of its septa. The sutures of the latter are directly transverse.

Occurrence.—In the Prosser member of the Trenton, at Wykoff, Minnesota; no. 4122, in the Robbins collection in the museum of the University of Minnesota.

10. **Orthoceras perparvum** Billings

Orthoceras perparvum Billings, Geol. Surv. Canada, Pal. Foss., *1*, 27 (1865).

The original description is as follows:

Length 3 or 4 inches; diameter at the last septum about 3 lines; section circular; siphuncle very small and very nearly central; septa gently concave, about one line distant, the last three or four much closer together. The chamber of habitation is 1 inch in length and tapers slightly from the last septum toward the aperture which is $\frac{1}{2}$ a line narrower than the diameter at the last septum. Surface unknown but the cast of the interior of

the chamber of habitation shows a number of very obscure annulations. Fragments of this species resemble *Cyrtoceras exiguum* but the chamber of habitation is twice the depth and the shell does not taper so rapidly. No perfect specimen has been seen but from the fragments that have been collected I think this species must be 3 or 4 inches in length, and is probably curved towards the smaller extremity. *Locality and Formation.*—Pallideau Islands. Northern part of Lake Huron. Black River limestone.

The type has been lost. However, from the original description several of its most striking characteristics become evident. The conch evidently was relatively long compared with its diameter. Compared with the species described by Billings as *Cyrtoceras exiguum*, the living chamber of *Orthoceras perparvum* was much longer and tapered only slightly and very inconspicuously toward the aperture. The obscure annulations on the surface of the cast of the interior of this chamber may be merely thickenings of the interior of the shell, such as often occur on the interior of living chambers, and may have no diagnostic value. The use of the generic term *Orthoceras*, rather than *Cyrtoceras*, suggests that the fragments of the conch actually at hand when Billings wrote his original description were not distinctly curved as in typical *Cyrtoceras exiguum*. Moreover, the phragmacone enlarged less rapidly. In fact, the chief resemblance of *Orthoceras perparvum* to the latter species consisted in its small diameter, circular cross-section, and the relative length of its camerae, the latter being about 1 mm. long where the diameter of the conch is 3 mm. The conch evidently was mature at a diameter of 6 mm., since at this diameter the upper three or four camerae are much shorter than those immediately beneath.

11. **Orthoceras vulgatum** Billings

Orthoceras vulgatum Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, 337 (1857).

The original description of this species is as follows:

> Section circular or very slightly oval, tapering at the rate of one line and a-half to the inch; siphuncle nearly central, small; septa concave, distant from each

other from two to two and a half lines. A fragment two inches and a-half in length, fourteen lines in diameter at the large end, and ten and a-half at the smaller, has twelve chambers. A second specimen, fourteen lines in diameter, has five chambers in a length of ten lines and a-half. A third, at a diameter of nine lines, has four chambers in a length of eight lines. *Locality and Formation.*—Trenton limestone, Ottawa.

The type has been lost. However, from the preceding data it is evident that the conch enlarged at an angle of 7 degrees. The number of its camerae in a length equal to the diameter of the conch increases from 4.5 where this diameter equals 19 mm. to 5.3 or 6.6 where this diameter equals 29.5 mm. In the absence of any knowledge of the structure of the siphuncle it will be difficult to identify this species, especially if found at some other locality than Ottawa.

GEISONOCERAS Hyatt

Genotype.—*Orthoceras rivale* Barrande, Systême Silurien du Centre de la Bohême, *2*, texte, pt. 3, 383 (1874); pl. 209, figs. 1–5 (1866).

Conchs transversely banded, the bands being relatively wide and flat, their upper margins abruptly delineated, their lower margins apparently invaginating into the tops of the immediately underlying bands. The siphuncle of the genotype expanding but slightly within the camerae, contracting moderately at the relatively short septal necks. Small calcareous deposits occur on the inner surface of these necks, but no actinoceroid structure is present.

In this genus, typified by the presence of distinct, wide, transverse bands, it has been customary to include those forms in which the surface is marked by raised transverse lines or striae, instead of bands.

12. **Geisonoceras scofieldi** Sp. nov.

Plate 10, figs. 1A, B

Orthoceras tenuistriatum Clarke, Geol. Minnesota, *3*, pt. 2, 788, pl. 55, figs. 4, 6 (1897).

Specimen consisting of a living chamber 47 mm. long, enlarging from a diameter of 18 mm. at its base to 22.3 mm. at a point

35 mm. farther up, and then contracting to 20 mm. at the aperture which is 6 mm. farther. The cross-section is circular. The septum at its base has a concavity of 4.5 mm. The suture of this septum rises slightly in a ventrad direction. The passage of the siphuncle through this septum is 1.5 mm. in diameter and its center is slightly over 6 mm. from the dorsal wall of the conch. The shell varies between a fourth and a third of a millimeter in thickness. Its surface appears almost smooth macroscopically, but under a lens there are 7 transverse striae in a length of 1 mm. These striae are low and almost equally distant. At various intervals there also are narrow and shallow transverse grooves, slightly more conspicuous than the raised lines or striae. Where the diameter of the conch is 21.5 mm., its circumference is estimated at 67.5 mm. At this level, the ventral side of the surface of the shell is marked by very narrow vertical lines, which are of a light brown color and only faintly darker than the shell itself. Of these vertical lines there are 25, and they occupy an area 22 mm. in width, at the level indicated, or almost one-third of the circumference of the conch. Along the lateral parts of the color-banded area these vertical color lines tend to be more distant from each other than along the middle two-thirds of this area. The width of these vertical color lines appears to vary between one-tenth and one-seventh of a millimeter.

Occurrence.—Cannon Falls, Goodhue county, Minnesota; in the Platteville member of the Black River. No. 204, in the Scofield collection in the museum of the University of Minnesota.

Remarks.—The specimen here described is imbedded within the lower third of a fragment of a spiculum or dart, the latter being formed by the matrix invading the interior of the cavity of the uppermost endocone of a species of *Endoceras*. The top of this spiculum apparently encloses part of the apical end of another specimen of *Endoceras*. All of the fossil parts here preserved are calcareous, and whitish or very light brown in color, except where in contact with the matrix, which is darker in color. The conch of the *Geisonoceras* apparently was lying on one of its lateral sides in the mud, and the darker colored matrix filled the lower part of about three-fourths of the cavity of the surrounding

endocone in this position, the remaining part being filled subsequently with infiltrating calcitic material, now more or less coarsely crystalline in structure.

The specimens described by Hall under the name of *Endoceras proteiforme* var. *tenuistriatum* are cited in the catalogue of the types and figured specimens in the American Museum of Natural History, published by Whitfield and Hovey in 1898 as coming from the Trenton, at Middleville, New York. In this species, at present referred to *Geisonoceras,* and no longer associated with *Endoceras proteiforme,* the transverse striae are crossed by vertical striae not more than one-fourth as large and visible only under a magnifier. As far as known, they show no trace of color markings. Moreover, in this Trenton species, the top of the living chamber does not contract toward the aperture.

13. **Geisonoceras drummondi** (Billings)

Plate 35, figs. 4A, B; 5A, B

Orthoceras drummondi Billings, Pal. Foss., *1,* 173, text fig. 156 (1865).

Two fragments were figured by Billings as though parts of the same specimen. One of these consists of the living chamber with parts of 5 camerae still attached. The other includes most of a phragmacone, and exposes 30 camerae with a trace of a thirty-first. Since there is considerable doubt as to these two specimens having formed part of the same individual, the living chamber with its attached camerae is selected here as the type.

This living chamber is 19 mm. long, appears to be straight, and the cast of its interior enlarges laterally from a diameter of 8.8 mm. at its base to 11 mm. at its top, the corresponding dorsoventral diameters being 8 mm. and 10.1 mm. Traces of the shell remaining attached to one of the slightly flattened sides of the chamber vary in thickness from 0.4 to 0.8 mm. The surface of this cast is faintly annulated, from 4 to 5 annulations occurring in a length of 5 mm. These annulations slope downward to one of the more flattened sides of the conch. In addition, this cast is contracted in an annular manner between 6 and 10 mm. above the base of the chamber, and also between 14 mm. and the aper-

ture. The surface of the shell is transversely striated and also supplied with low and broad undulations, apparently without any connection with the faint annulations on the surface of the cast of the interior of the conch. The upper 4 camerae occupy a total length of 2.5 mm., the fifth has a length of 0.75 mm. The sutures of the septa are directly transverse. The location of the siphuncle can not be determined. The lateral apical angle of this specimen is about 7 degrees. Plate 35, figs. 4A, B.

The lateral apical angle of the second fragment is about 9.3 degrees. Its lateral diameter enlarges from 4.2 mm. at its base to 8.5 mm. at a point 24 mm. farther up. At the top of this fragment its dorsoventral diameter is estimated at 7.5 mm. Where its lateral diameter is 5 mm., 5 camerae occur in a corresponding length. Where it is 7 mm., 8 camerae occur in a corresponding length; and where it is 8.5 mm., 11 camerae occur. In its present condition the conch is distinctly curved lengthwise, and if the convexly curved side is regarded as ventral, then the sutures of the septa are directly transverse laterally, but curve slightly, but distinctly, downward between the ventrolateral parts of the conch. No trace of the siphuncle can be detected. The thickest part of the shell seen in cross-section at the top of the specimen is 0.3 mm. in thickness. Plate 35, figs. 5A, B.

Occurrence.—Near Kingston, Ontario; in the Black River. No. 1271, and 1271a, in the order here described; in the National Museum of Canada.

Remarks.—The two fragments here described evidently came from the same strata, at least their matrix appears identical lithologically. The first fragment is characterized by its straightness, the faint annulation of the cast of the interior of the living chamber, and the straightness of the sutures of its septa. The second is characterized by the larger angle of its enlargement laterally, its lengthwise curvature, and the downward curvature of the sutures of its septa along the convexly curved side of the conch.

The statement by Billings, that the siphuncle was small, slightly dilated between the septa, and situated close to the margin, but not in contact with the shell, probably was based on another specimen, and not on the two fragments figured by him. See

in this connection the remarks under *Kentlandoceras wilsonae Foerste.*

CYCLOCERAS McCoy

Genotype.—*Orthoceras annulare* Fleming, Synop. Carb. Foss. Ireland, 6, 10 (1844).

Annulated conchs, with transverse striae, but without vertical markings of any kind.

In the text following the original description of *Cycloceras*, McCoy referred three species to that genus. The first of these, originally described by Fleming as *Orthocera annularis*, was selected by Bassler, in his Bibliographic Index of American Ordovician and Silurian Fossils (Bull. 92, U. S. National Museum (1915) as the genotype. The second, *Cycloceras laevigatum* McCoy, was selected as genotype by Carey Croneis, 11 years later (Amer. Jour. Sci., *12*, 185–192 (1926)). The writer agrees with Croneis that the genotype must be selected from the 3 species referred by McCoy to this genus at the time of his original description, but adopts the first selection thus made.

In his British Palaeozoic Fossils, published in 1852, 1855, McCoy included under the term *Cycloceras* all annulated forms known to him, forms which were separated later, by Hyatt, into the genera *Cycloceras*, *Spyroceras*, and *Dawsonoceras*. Hyatt's first definition of *Cycloceras*, as restricted by him, was as follows: "Transversely striated Palaeozoic longicones, which at some stage of growth have annular costae. The young are invariably smooth, that is, marked only by transverse striae of growth, and the annulations are subsequently introduced." (Proc. Boston Soc. Nat. Hist., *22*, 275 (1884). In *Spyroceras*, on the contrary, the longicones are ridged longitudinally, and at some stage of their growth are also annulated; while in *Dawsonoceras* the conchs are annulated, and have frilled transverse striae, longitudinal markings being present in some species at some stages of growth.

The original description of *Cycloceras* by McCoy was incorrect in two respects, if the three species referred by him in the later part of the same text are to be regarded as a guide. In the first place, in his description of the genus he stated that the location

of the siphuncle was dorsal, and he so indicated its location in one of the accompanying small figures. In the second place, on the other accompanying figure he represents the conch as vertically striated or ribbed, the ribs being relatively distant from each other. Neither of these features is to be found in any of the three species referred to *Cycloceras* on later pages of the same text. These inaccuracies may have given rise to Hyatt's later revision of his description of *Cycloceras* into the following form: "Annulated orthoceracones and cyrtoceracones with discontinuous longitudinal ridges. Siphuncle generally tubular or with fusiform segments; deposits when present irregular as in *Orthoceras*. Annuli often become obsolete in parageronic stages."

Following the rule that the genotype must be selected from among the species referred to the genus under consideration at the time of its original description, the first species mentioned by McCoy was selected by Bassler, and is here adopted.

It is, of course, of interest to learn what McCoy had in mind when he described the siphuncle of *Cycloceras* as dorsal in location, and figured the conch as vertically ribbed. The only species known to the writer which could have served as a basis for these figures is that originally described by Fleming under *Orthocera rugosa*, and figured by Phillips under *Orthoceras rugosum*, and then listed by McCoy, in his British Palaeozoic Fossils, fasc. 3, 573, (1855), as *Orthoceras* (*Cycloceras*) *rugosum*. By Foord it was referred to *Cyrtoceras* (*Meloceras*) *rugosum*. McCoy described the vertical markings of this species as consisting of 26 equal, filiform, slender, tubercular ridges; siphuncle minute, close to the convex margin.

14. **Cycloceras decrescens** (Billings)

Plate 12, figs. 1A, B, C

Orthoceras decrescens Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, 337 (1857).

Two specimens are at hand. The larger specimen originally was 97 mm. in length but later was broken across at a point about 22 mm. above its base, and its upper part was then sectioned

dorso-ventrally. The two halves of the sectioned part are numbered 1277 c, d, respectively, and the short lower fragment is numbered 1277 e. This specimen enlarged from the diameter of 15.5 mm. at its smaller end to 28 mm. at a point 80 mm. farther up, its angle of enlargement being 9 degrees. Both the surface of the shell and the cast of the interior of the conch are strongly annulated. Along the lower third of the specimen about 7 annulations occur in a length equal to the diameter of the conch, increasing to 8 along its upper two-thirds. At the top of the specimen, where the annulations are between 4 and 4.5 mm. apart, the height of these annulations above the intervening grooves is between 0.8 and 0.9 mm. The smaller fragment shows traces of sharply defined but narrow raised lines, relatively distant from each other, at one point numbering 4 in a length of about 1.2 mm. within the groove between two annulations. Plate 12, fig. 1A.

The second specimen originally was about 72 mm. long. Later it was broken across about 32 mm. above its base and its upper part was sectioned dorsoventrally. At its larger end its diameter is about 22 mm. From this it tapers in a length of 60 mm. to 15 mm. Only the phragmacone is included. There are 6.7 camerae in a length equal to the diameter of the conch at the top of the series counted. The center of the siphuncle is 8 mm. from the ventral wall of the conch where the diameter of this conch is 20 mm. The concavity of the septa here is 4 mm. The segments of the siphuncle are 3.2 mm. in diameter, contracting to 2.6 mm. at the septal necks. These necks are short. The dorsal outlines of the segments of the siphuncle are only slightly convex, while their ventral outlines are more strongly curved, reaching their maximum convexity at about three-fifths of their length above the base of each segment. The sutures of the septa are almost directly transverse, but appear to slope slightly downward in a dorsad direction. The lower fragment of this specimen, numbered 1277 b, shows traces of transverse raised lines or striae, on the crest of one of the annulations; these transverse lines are somewhat more numerous than the corresponding lines which in the preceding specimen occupied the grooves between the annulations.

The two halves of the upper part of this specimen are numbered 1277 and 1277a respectively. Plate 12, figs. 1 B, C.

Occurrence.—LaPetite Chaudiere, Ottawa River, just above Ottawa City, Ontario, Canada; in the Black River formation. Cotypes, numbered 1277, in the National Museum of Canada.

Remarks.—Although the transverse raised lines are distinctly indicated locally on both specimens, no vertical markings of any kind can be detected. Hence the reference of this species to *Cycloceras*.

15. **Cycloceras** cf. **decrescens** (Billings)

Plate 12, figs. 7; 5 A, B

Several specimens found on St. Joseph Island differ from typical *Cycloceras decrescens* (Billings) only in the slightly greater prominence of their annulations.

The largest specimen, number 14419, is 86 mm. long, and enlarges from a diameter of 20 mm. at its base to 26 mm. at a point 60 mm. farther up, its angle of enlargement being 6 degrees. Surface ornamented by conspicuous annulations, varying in number from 6 in a length equal to the diameter of the conch along the lower part of the specimen to 7 along its upper part. Along the upper part of this specimen the annulations rise fully 1 mm. above the intermediate grooves. The sutures of the septa occupy the bottom of these grooves, indicating that the camerae are about equal in number to the annulations. The uppermost suture exposed is at a diameter of 24 mm. The septum at the base of the specimen has a concavity of 2.5 mm., and the center of the siphuncle here is 7 mm. from the nearest wall of the conch, the diameter of the latter being 20 mm. Along the upper part of the specimen there are traces of very narrow raised transverse lines on several of the grooves and on one of the annulations. In one groove they occur at the rate of 4 lines in a length of 2 mm., but they are somewhat more crowded on the immediately overlying annulation. Collected by Alexander Winchell. Plate 12, fig. 7.

Several smaller specimens, were collected by Carl Rominger. One of these, numbered 14455, is 44 mm. long, and enlarges in

diameter from 12.5 mm. near its base to 16.5 mm. at a point 32 mm. farther up, its apical angle being 7 degrees. Six annulations occur in a length equal to the diameter of the conch. These are elevated 1 mm. above the intermediate grooves at the top of the specimen. Their crests are rounded rather narrowly, so that the annulations appear narrower than the intermediate grooves. A second specimen, numbered 14454, 40 mm. in length, enlarges from a diameter of 12 mm. at its base. The height of the camera here is 3.8 mm., the siphuncle enlarging from 1.1 mm. at its septal neck to 2.7 mm. at mid-height of the segment within the camera, the center of the siphuncle here being 4 mm. from the nearest wall of the conch. Plate 12, figs. 5A, B.

Occurrence.—St. Joseph Island, Lake Huron, Canada; in the Black River formation. In the Museum of the University of Michigan.

Remarks.—The transverse lines of these specimens closely resemble those on the surface of the shell of typical *Cycloceras decrescens*.

16. **Cycloceras** sp. (Minnesota)

Plate 12, figs. 4, 3

Orthoceras olorus Clarke, Geol. Minnesota, *3*, pt. 2, 788, pl. 55, figs. 3, 5 (1897).

Two specimens were mentioned by Clarke in his description of the species he identified as *Orthoceras olorus*. The one having 5 annulations in a length of 25 mm., and a diameter of 30 mm., is the one he figured as coming from Minneapolis, Minesota. The other, with 9 annulations in a length of 45 mm., was not figured. It is labelled as coming from Janesville, Wisconsin, and is numbered 8291 A. Both specimens differ from typical *Spyroceras olorus* in the absence of vertical markings, and in the greater rate of enlargement of the conch.

Minneapolis specimen.—Specimen 42 mm. long, enlarging from a maximum diameter of 29 mm. at its base to about 33 mm. at a point 23.5 mm. farther up. The conch was compressed and obliquely distorted by pressure after the death of the animal. In its present condition the minimum diameter at its base is 25 mm.

Five annulations occur in a length of 23.5 mm., indicating the former presence of 6.6 annulations in a length equal to the maximum diameter of the conch. The crests of these annulations rise 2 mm. above the intervening grooves. At present the annulations slope downward parallel to the shorter transverse axis of the conch. Distinct traces of sutures of septa occur in the lower two transverse grooves, showing the presence of at least two camerae. The specimen is chiefly a cast of the interior of the conch, but a thin film of the surface of the shell remains, and in the second groove above the base of the specimen this film retains distinct but very fine raised transverse lines, about 4 in a length of 2 mm., similar to those of *Cycloceras decrescens*. There is no trace of vertical markings. No. 8291. Plate 12, fig. 4. No. 8291, Univ. of Minnesota.

Janesville specimen.—This is the specimen described by Clarke as having 9 annulations in a length of 45 mm. It is 60 mm. long, is compressed laterally, and enlarges dorsoventrally from a diameter of 26 mm. to 28.5 mm. in a length of 22.5 mm. No surface markings are preserved, but it closely resembles the Minneapolis specimen just described in the prominence and relative number of its annulations, and possibly also in its rate of enlargement. No. 8291 A, Univ. of Minnesota. Plate 12, fig. 3.

Occurrence.—Both specimens, the one from Minneapolis, Minnesota, and the one from Janesville, Wisconsin, were obtained from the Platteville member of the Black River formation, and both are preserved in the museum of the Univ. of Minnesota.

17. **Cycloceras** (?) sp. (Janesville)

Plate 12, fig. 2

A second specimen from Janesville, Wisconsin, retains no distinct traces of surface markings, aside from the conspicuous annulations. These annulations are much less conspicuous than those of the two specimens described in the preceding section, thus suggesting a distinct species. This specimen is 56 mm. long, including a living chamber 47 mm. in length, and part of the uppermost camera of the phragmacone. The living chamber evidently contracted gradually from its base toward the aperture.

At the annulation 33 mm. above the base of the living chamber the lateral diameter is 30 mm. and the dorsoventral one is 28.5 mm. The interval between the annulation beneath and the one immediately above the suture at the base of the living chamber is 6.5 mm., the overlying 4 intervals each averaging 7.5 mm. in length, the uppermost annulation being 13 mm. from the aperture. This is a gerontic condition noted in many species of *Cycloceras*, *Spyroceras*, and *Dawsonoceras*.

Occurrence.—Janesville, Wisconsin; in the Platteville member of the Black River formation; in the museum of the Univ. of Minnesota.

18. **Cycloceras romingeri** Sp. nov.

Plate 12, figs. 6A, B

Conch closely resembling *Spyroceras arcuoliratum* (Hall) from the Trenton of New York, but with conspicuous transverse striae, and with no trace of vertical markings.

Holotype 32 mm. long, 8.1 mm. in diameter at its base, with no perceptible increase in diameter in the length preserved. Five annulations occupy a total length varying from 8.2 mm. to 8.5 mm. The crests of these annulations rise about half a millimeter above the intermediate grooves. As in *Spyroceras arcuoliratum*, the annulations rise strongly in a ventrad direction along the ventral half of the conch, but have a much more moderate rise in the same direction on its dorsal half. The crests of the second and third annulation above the base of the specimen show traces of relatively coarse transverse striae which occur at intervals suggesting 6 or 7 striae in a length of 1 mm.

Occurrence.—St. Joseph Island, in Lake Huron, Canada; in the Black River formation. Holotype. No. 2831, in the museum of the University of Michigan.

POLYGRAMMOCERAS Foerste

Genotype.—*Polygrammoceras twenhofeli* Foerste, in Twenhofel, Geology of Anticosti Island, Geol. Surv. Canada, memoir 154, p. 264, pl. 29, figs. 3, 4 (1927).

If the term *Kionoceras* be restricted to those orthoceracones in which the surface of the shell is vertically ribbed and fluted, and if

the term *Protokionoceras* be restricted to those orthoceracones in which the fluted areas between the ribs are striated vertically, there remains unassigned a group of orthoceracones in which the surface of the shell is vertically striated, but not vertically ribbed so as to leave intermediate fluted areas. For this unassigned group of species the name *Polygrammoceras* was proposed. The vertical striae are much more numerous than in typical *Kionoceras*. Their crests are flat or only slightly convex, the interspaces or grooves being similarly flat and shallow. Those species in which the vertical striae are narrow and sharp are more distantly related.

19. **Polygrammoceras prestonense** Sp. nov.

Plate 14, fig. 2

Orthoceras cf. amplicameratum Clarke, Geol. Minnesota, *3*, pt. 2, 790, pl. 47, fig. 19 (1897).

Specimen 74 mm. long enlarging from a diameter of 26.5 mm. at its base to 30 mm. at a point 40 mm. farther up, and to 32 mm. at its top, indicating an apical angle of 5 degrees. The number of camerae within a length equal to the diameter of the conch varies from 3.5 along the lower half to the specimen to 4 along its upper part. The sutures of the septa apparently were directly transverse to the vertical axis of the conch, but there is no other trace of the septa nor is there any indication of the size, structure, or location of the siphuncle. The surface of the specimen, which is a cast of the interior of the conch, retains traces of the vertical striae which formerly ornamented the surface of its shell. These are equidistant, and number 7 in a width of 5 mm. They are low and relatively broad, and distinguishable only with difficulty in the present condition of the shell, though probably distinct on the original shell.

Occurrence.—Preston, Minnesota; referred by Bassler, in his Index of Ordovician and Silurian fossils, to the Trenton, presumably from its Prosser member. No 8255, in the museum of the University of Minnesota.

Remarks.—In typical *Orthoceras amplicameratum*, from the

Trenton at Middleville, New York, the number of camerae in a length equal to the diameter of the conch is between 2 and 2.5 where equal in size to the Minnesota specimen here described.

Ruedemann refers *Orthoceras amplicameratum* to the genus *Geisonoceras*, in studies based on specimens from the upper Utica shale of New York.

KIONOCERAS Hyatt

Genotype.—*Orthoceras doricum* Barrande, Systême Silurien du Centre de la Bohême, *2*, texte III, p. 242 (1874); pl. 269, figs. 1–13 (1868).

The genotype apparently includes at least two species, possibly three. In Barrande's figure 1 the grooves between the primary ribs are occupied by secondary and tertiary vertical striae as in *Protokionoceras* of Grabau and Shimer. In his figure 7 the vertical striae occupying the grooves between the primary ribs are more numerous and are of approximately the same size. In his figures 4, 9, and 12 the grooves between the primary striae are conspicuously striated in a transverse direction, vertical striations being faint or nearly obsolete. As far as known, no one has hitherto definitely selected one of the three types of surface ornamentation present in Barrande's composite species *doricum* as the type of that genus. Since one of these is somewhat similar to that of the *Orthoceras medullare* Hall, selected by Grabau and Shimer as genotype of *Protokionoceras*, the third form of surface ornamentation presented by Barrande's species, namely that with conspicuous transverse striae and inconspicuous or obsolete vertical striae is selected here as type of that species and as genotype of the genus *Kionoceras*. For the intermediate forms with numerous fine vertical striae no new name is offered, these forms remaining provisionally in *Kionoceras*, though evidently closely related to *Protokionoceras*. The general group including *Kionoceras* and *Protokionoceras* requires further study.

The species *Kionoceras allumettense*, *K. huronense*, and *K. multistriatum* apparently are intermediate between typical *Polygrammoceras* and *Kionoceras*.

20. **Kionoceras paquettense** Sp. nov.

Plate 37, figs. 2A, B

Specimen 47 mm. long, slightly curved, the concavity of its dorsal outline equalling 1 mm. within this length. The specimen enlarges from a diameter of 4.5 mm. near its base to 10 mm. at a point 40 mm. farther up, its apical angle being 8 degrees. The surface of the specimen is marked by about 35 vertical ribs, most of which are approximately equal in size and in their distance apart; however, the 6 or 8 ribs along the median part of its dorsal side are separated by narrower intervals, and there are traces of about 10 additional vertical secondary striae in the grooves occupying the broader intervals, so that the total number of vertical lines equals about 45. The concavity of the septum at the top of the specimen is 1.8 mm., and the center of the siphuncle here is 3.7 mm. from the dorsal wall of the conch. The diameter of the siphuncle is 1.3 mm. and the only segment exposed is cylindrical in form and does not enlarge within the camera. Only one camera is preserved, and that is located at the top of the specimen and is 3 mm. long.

Occurrence.—Paquette Rapid, on the Ottawa river, at Allumette Island; from the Leray member of the Black River. No. 6827, National Museum of Canada.

Remarks.—This specimen is readily distinguishable from *Kionoceras trentonense* Foerste,[1] from the middle part of the Trenton at Middleville, New York, by the greater rate of enlargement of its conch, and the greater number of its vertical primary ribs. These ribs are relatively low, and the intermediate grooves are shallow.

In general size, curvature, and vertical striation it resembles the specimen figured by Hall under *Orthoceras laqueatum*, but the latter has only about 20 vertical ribs within the circumference of the conch, and probably was obtained from some part of the Canadian of New York.

[1] Foerste, A. F., Jour. Sci. Lab. Denison Univ., *19*, 275, pl. 35, fig. 1 (1921).

21. **Kionoceras huronense** Sp. nov.

Plate 22, figs. 6A, B

Specimen 12 mm. long, enlarging in this length from a maximum diameter of 6 mm. at its base to 6.5 at its top, indicating an apical angle of about 2.3 degrees. The minimum diameter at its top is 5.6 mm. There are 3 camerae, averaging 4 mm. in height. The concavity of its septa is 1 mm. The siphuncle is central in location and 1 mm. in diameter at its passage through the septum at the top of the specimen. There are about 30 vertical primary raised lines or ribs, with a few intermediate secondary lines where the intervals between the primary ones are broader. The primary ribs are very low and narrow, about one-twentieth of a millimeter in width, and the intermediate spaces are relatively flat. There are no distinct transverse lines, even under a lens.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype, no. 14426, in the museum of the University of Michigan.

Remarks.—This specimen is characterized by its slow rate of enlargement, its relatively tall camerae, the narrowness of its primary vertical ribs, and the relative flatness of its intermediate spaces.

22. **Kionoceras allumettense** Sp. nov.

Plate 22, fig. 5

Specimen 21 mm. long, enlarging in a length of 20 mm. from a diameter of 4 mm. at its base to 5 mm. farther up, indicating an apical angle of 3 degrees. Its surface is marked by 22 equally distant and prominent vertical ribs. These ribs are separated by relatively deep intermediate grooves, considering the small size of the specimen. The crests of the ribs are rounded. The concavity of the septum at the top of the specimen is almost 1 mm. The siphuncle here is 0.7 mm. in diameter and is located at the center of the septum.

Occurrence.—Paquette Rapid, on the Ottawa river, at Allum-

ette island; in the Leray member of the Black River formation. No. 6828, National Museum of Canada.

Remarks.—Among specimens described and figured, this specimen resembles most closely the one figured by Hall under the name *Orthoceras laqueatum ? var. a*,[2] from the lower shaly strata of the Trenton at Middleville, New York. From *Kionoceras trentonense* Foerste,[3] from the middle portion of the Trenton at Middleville, New York, it differs in the total absence of any trace of secondary vertical striae in the grooves between the primary vertical ribs.

23. **Kionoceras multistriatum** Sp. nov.

Plate 22, figs. 7A, B, C

Specimen 39 mm. long, enlarging from a diameter of 3.3 mm. at its base to 4.8 mm. at a point 37.5 mm. farther up, its apical angle being 2.5 degrees. The number of its camerae within a length equal to the diameter of the conch varies from 2.5 mm. along the lower end of the specimen to 2.6 along its upper end, with a restricted intermediate part along which they occur at a rate of at least 4 within a corresponding length. The sutures of the septa appear directly transverse dorsally, but ventrally they curve distinctly downward, the change to a downward curvature being abrupt. The location of the siphuncle is central, and its diameter at the septal neck is 0.6 mm. where the diameter of the conch is 4.5 mm. There are about 52 to 54 vertical ribs at the upper end of the specimen. Almost all of these are essentially of the same size, though a few are sufficiently smaller to be designated as secondary. The spaces between these ribs are distinctly, though only moderately, concave. Under a strong magnifying lens numerous very fine and closely crowded transverse raised lines are visible which curve only moderately downward dorsally, but which ventrally rise at an angle of 25 degrees above the horizontal, arching upward strongly along the median part of the ventral side of the conch.

[2] Hall, James, Pal. New York, *1*, 206, pl. 56, fig. 3 (1847); also Foerste, A. F., Jour. Sci. Lab. Denison Univ., *19*, 276, pl. 35, fig. 2 (1921).

[3] Foerste, A. F., Jour. Sci. Lab. Denison Univ., *19*, 275, pl. 35, fig. 1 (1921).

In addition, the ventral side of the conch is crossed by numerous dark brown transverse bands, one beneath each of the septa. These bands terminate abruptly laterally along an imaginary vertical line, the width of the banded area equalling three-eighths of the circumference of the conch. The narrower bands vary from 0.3 mm. to 0.6 mm. in vertical width, but in some of the lower camerae the dark-brown coloring matter extends downward from the overlying septum almost as far as the septum next beneath. As far as it is possible to determine without actually sectioning the specimen, the coloring matter is in the form of a thin film lining the interior side of the shell, and therefore is referable to the exterior of the matrix, rather than to the shell itself. It is visible through the thin translucent shell.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype, No. 2462, in the museum of the University of Michigan.

Remarks.—This specimen is characterized by its numerous subequal vertical ribs or striae, and the slow rate of enlargement of the conch.

SPYROCERAS Hyatt

Genotype.—*Orthoceras crotalum* Hall, Pal. New York, *5*, pt. 2, pls. 42, 82, 113 (1879).

The conch of *Orthoceras crotalum* is crossed transversely by strong, sharply defined, and rather distant annulations. The vertical striae are very fine and closely crowded. There are no corresponding fine transverse striae.

In Ordovician and Silurian strata, species of *Syproceras* with numerous vertical striae of approximately uniform size are relatively common, forming a *lineate* group. About equally common is the *bilineate* group, in which the vertical markings are alternately stronger and weaker, the stronger markings often being called ribs. When transverse markings occur these usually are much weaker than the ribs. In the *cancellated* group, numerous fine vertical striae are crossed by approximately an equal number of fine transverse striae, this group being typified by *Spyroceras textile* (Hall) and *Spyroceras microcancellatum* Foerste. The num-

ber of cancellated species is small. The scalariform group has relatively distant vertical ribs crossed by distinct and relatively large transverse raised lines, as in *Spyroceras beauportense* Whiteaves. The number of scalariform species also is small. The structure of the siphuncle is known only in relatively few of the species referred to *Spyroceras,* so that there is a possibility of distinct generic groups being included under this single term.

24. **Spyroceras arcuoliratum** (Hall)

Plate 11, fig. 2

Orthoceras arcuoliratum Hall, Pal. New York, *1,* 198, pl. 42, figs. 7a (not 7b), (1847).

The original of Hall's figure 7a is selected here as the type of the species. It is 56 mm. long, and enlarges dorsoventrally from a diameter of 6 mm. at its base to 8.6 mm. at a point 47 mm. farther up, its angle of enlargement being approximately 2.6 degrees. The septa are not exposed clearly and their distance apart can not be determined with confidence. Where the dorsoventral diameter is 6.8 mm. there are 5 annulations in a corresponding length, increasing to 6 annulations at a diameter of 9 mm. It is not known which side of the conch is ventral, but, in analogy with *Metaspyroceras,* it is assumed that the side toward which the annulations rise is the ventral one, though the only true guide for determining the ventral side of a conch is the location of the hyponomic sinus, if one be present. In the specimen at hand the annulations rise slowly from the supposed dorsal side of the conch in a ventrad direction for a little more than half the width of the conch, forming an angle of about 5 degrees with a directly transverse plane, and then rise rather abruptly at an angle of 20 degrees with this plane. The elevation of the annulations is scarcely more than one-fifth of a milimeter. Along the upper part of the specimen there are 7 very fine vertical raised lines in a width of 2 mm., alternating slightly in size. In addition, the lens reveals also closely crowded transverse lines, which curve distinctly downward on crossing the median part of the supposed ventral side of the conch.

Occurrence.—Middleville, New York; in the Trenton formation.

One of two specimens numbered 807, in the American Museum of Natural History.

25. **Spyroceras cylindratum** Sp. nov.

Plate 11, figs. 3A, B; 6A, B; 7A, B, C

Orthoceras arcuoliratum Hall, Pal. New York, *1*, 198, pl. 42, figs. 7b, c (not 7a), (1847).

The original of Hall's figures 7b and 7c, cited above, differs conspicuously from the type of *Spyroceras arcuoliratum* in its smaller angle of enlargement. In other respects it is closely similar. This specimen is 48 mm. long, and enlarges from a diameter of 11.2 mm. at its base to 12.2 mm. at its top, enlarging at an angle of approximately 1.3 degrees. Where its diameter is 12 mm. there are 6 annulations in a corresponding length. These annulations rise from the supposed dorsal side of the conch in a ventrad direction for about half the width of the conch and then more rapidly for the remainder of its distance to its ventral outline, in this respect closely resembling *Spyroceras arcuoliratum*. The specimen is a cast of the interior of the conch and retains no trace of vertical raised lines. The only septum exposed is that at the base of the specimen. The suture of the latter appears to slope slightly downward toward the supposed dorsal side of the conch. The concavity of this septum equals 2 mm. and the passage of the siphuncle through this septum is 2 mm. in diameter, its location being only slightly ventrad of the exact center of the conch. Plate 11, figs. 3A, B.

Occurrence.—Watertown, New York; in the more coarse-grained part of the Trenton. One of two specimens numbered 807 in the American Museum of Natural History.

At the Paquette rapid, Allumette Island, Quebec, Canada, on the Ottawa River, numerous fragments of an annulated species closely similar to the one represented by Hall's fig. 7b, occur (Plate 11, figs. 6A, B; 7A, B, C). None of these fragments exceeds 40 mm. in length or 12 mm. in diameter. The largest specimen preserving a trace of a septum is only 9.5 mm. in diameter, but the camerated part of the conch probably attained larger diameters than this. The size of fully mature specimens is unknown.

All of these specimens enlarge at a smaller apical angle than typical *Spyroceras arcuoliratum*. The annulations slope downward from the median part of the ventral side of the conch in a dorsad direction at an angle of 25 to 30 degrees with the horizontal as far as its dorsolateral side, dorsad of which they continue their course almost horizontally or with only a slight downward slope. This is in strong contrast with the strong upward arching of these annulations along the median part of their ventral course. The number of these annulations in a length equal to the diameter of the conch varies from 3.5 to 4 where this diameter does not exceed 4 mm., but increases to 4.5 and 5 annulations at diameters between 5 mm. and 9.5 mm., and in one fragment 12 mm. in diameter there are 5.6 annulations in a corresponding length. The number of camerae in a length equal to the diameter of the conch is less than 2. In a specimen 7.8 mm. in diameter near its lower end, each of 2 camerae there exposed is 4.3 mm. in length. The sutures of the septa are directly transverse to the vertical axis of the conch, and therefore deviate strongly from the course of the oblique annulations. In a specimen 9.5 mm. in diameter, the diameter of the siphuncle at its passage through the septum is 1 mm., and its location is central. All of the specimens are silicified and most of them do not preserve the surface sufficiently well to retain minute striae; however, the general impression in most specimens is that of a smooth shell. However, there is a single specimen, 18 mm. long and 4 mm. in diameter, which on cross-illumination appears distinctly striated vertically, with 7 striae in a width of 3 mm. On the basis of this single specimen, the entire series at hand is assumed to have been striated vertically before silicification, and therefore all are here referred to the genus *Spyroceras*.

Occurrence.—Paquette rapid, Quebec, on the Ottawa River, Canada; in the Leray member of the Black River formation. No. 6829, in the National Museum of Canada.

26. **Spyroceras teretiforme** (Hall)

Plate 11, figs. 5A, B

Orthoceras teretiforme Hall, Pal. New York, 1, 198, pl. 42, figs. 8a, b, (1847).

Specimen forming the lower half of Hall's figure 8a, 43 mm. long, its base being occupied by the ventral valve of that species of *Dalmanella* which is common in the Trenton of New York. Fragments of *Sowerbyella* are imbedded in the matrix at its top. This fragment of the conch enlarges dorsoventrally from a diameter of 16 mm. at its base to 20 mm. at a point 37 mm. farther up. At the latter point the corresponding lateral diameter is about half a millimeter greater. The dorsal outline of the conch is essentially straight, but its ventral outline is distinctly convex, though this convexity scarcely equals 1.5 mm. The specimen is crossed by 9 annulations, of which the lower 5 occupy a length equal to the dorsoventral diameter of the conch, while the upper annulations occur at the rate of 4.3 in a length equal to a corresponding diameter. The annulations slope downward in a dorsad direction at an angle of 5 degrees along the lower part of the specimen, increasing to 8 degrees along its upper part. Along the median part of its dorsal side this downward slope is distinctly accentuated, the width of this accentuated part equalling 15 mm. along the upper end of the specimen. The height of the annulations equals half a millimeter or is only slightly greater. There are faint traces of vertical raised lines, as in other species of *Spyroceras*. There is a faint trace of a transverse line along the bottom of the groove which is 15 mm. above the base of the specimen. This is interpreted as the suture of a septum. In that case, the living chamber is about 25 mm. long. Apparently 4 camerae occupied a length of 15 or 16 mm., but this can not be asserted with confidence.

Occurrence.—Watertown, New York; in the Trenton limestone, the matrix being relatively granular, and dark gray, rather than black, in color. Specimen no. 12412, in the New York State Museum, at Albany.

Remarks.—This species resembles *Spyroceras ruedemanni* Foerste in the straightness of its dorsal outline, and the convexity of its ventral outline; also in the relative coarseness of its vertical striae, as far as can be determined from the specimen at hand. Moreover its annulations show a similar downward slope in a dorsad direction. The specimen used for the upper half of Hall's figure is lost.

27. **Spyroceras allumettense** Sp. nov.

Plate 11, figs. 8A, B; 9

Two specimens occur in the collections from the Pauquette Rapids which differ from typical *Spyroceras arcuoliratum* in the relatively small rise of the annulations on the ventral side of the conch.

One of these is 103 mm. long, and enlarges in this length from a diameter of 4 mm. at its base to 10 mm. at its top. At its upper end there are 5 annulations in a length corresponding to the diameter of the conch. The annulations curve downward slightly along the median part of the dorsal side, and tend to become slightly less elevated there. Laterally they are horizontal for such a width that not sufficient room is left for a strong rise of the annulations ventrally. There are faint traces of vertical markings along the upper part of one of the lateral sides. Plate 11, figs. 8A, B.

The second specimen is nearly 45 mm. long and is 15 mm. in diameter along its upper part. There are 6 annulations in a length equal to the diameter of the conch. These annulations rise only slightly along the upper part of the specimen but more strongly near its base. Four camerae occur in a length equal to the diameter of the conch. The concavity of the septa equals 2 mm. The location of the siphuncle is uncertain. Plate 11, fig. 9.

Occurrence.—Paquette Rapids, Allumette Island, Ottawa River, between Ontario and Quebec, Canada; in the Black River formation. Specimens No. 6830, in the National Museum of Canada.

28. **Spyroceras iowense** Sp. nov.

Plate 11, fig. 4

Orthoceras anellus. Clarke, Geol. Minnesota, *3*, pt. 2, 784. pl. 47, figs. 22, 23 (1897).

Specimen 21 mm. in length, its diameter enlarging from 10.9 mm. at its base to 11.4 mm. at a point 14 mm. farther up. At this rate the apical angle of the specimen equalled about 2 degrees. About 5 annulations occur in a length equal to the diameter at the top of the series counted. The annulations are broadly rounded,

about as wide or a little wider than the intervening grooves, and elevated about 0.6 mm. above the lowest part of the latter. The surface of the conch is ornamented by about 64 vertical ribs which are remarkably prominent, considering the small size of the fragment. Moreover, the alternation in size of these ribs is so slight that they might be called subequal. The spaces between the ribs are in part slightly wider, and in part slightly narrower than the ribs themselves. There may have been transverse striae on the surface of the original shell, but no trace of these can be detected on the specimen in its present condition. The concavity of the septum at the base of the specimen equals about 1.75 mm. Here, where the diameter of the conch at the groove between the annulations is 9.3 mm., the center of the siphuncle is 4 mm. from the nearest wall of the conch, and its diameter is 1.1 mm. No other septa are exposed.

Occurrence.—McGregor, Iowa; collected by Charles Schuchert from the Decorah member of the Black River. It is a silicified specimen, weathered light brown at the surface, whitish within, and its exact origin stratigraphically requires determination. No. 8290, Univ. of Minnesota.

Remarks.—Typical *Spyroceras anellus* was described by Conrad from Mineral Point, Wisconsin, in the Beloit member of the Black River. In this species the annulations are more narrowly rounded, and more prominent. The surface of its shell is ornamented by numerous minute filiform raised vertical lines, about 9 in a width of 1 mm. From this type the species here described from Iowa differs conspicuously in its relatively lower and broader annulations, and in its much more prominent and more distant vertical ribs.

29. **Spyroceras lesueuri** (Clarke)

Plate 12, fig. 8

Orthoceras lesueuri Clarke, Geol. Minnesota, *3*, pt. 2, 785, pl. 55, fig. 9 (1897).

Specimen 59 mm. long, the upper part, 33 mm. in length, preserving no trace of septa, and therefore regarded as belonging to the living chamber. Its dorsoventral diameter enlarges from 11.3

mm. at its base to 13.6 mm. at a point 43 mm. farther up, indicating an angle of enlargement of 3 degrees. The surface of the conch is crossed by slightly oblique annulations which slope downward in a supposed dorsad direction at an angle of about 5 degrees with the horizontal. The number of these annulations in a length equal to the dorsoventral diameter of the conch increases from 7 along the lower half of the specimen to 8 along its third quarter, and then decreases to 6 along its upper quarter. This lengthening of the intervals between the annulations along the upper part of the living chamber is a feature noted in other orthoconic annulated genera, such as *Cycloceras* and *Dawsonoceras*. In the specimen here under consideration, the sutures of the septa are located in the grooves between the annulations, and therefore correspond to the latter in number. They are slightly less inclined to the horizontal than the annulations, and therefore are slightly nearer the crests of the annulations immediately beneath on that side of the conch toward which the annulations rise. The concavity of the septum at the base of the specimen equals 2 mm. The siphuncle is not preserved but is assumed to be approximately central. The conch is compressed laterally, evidently owing to pressure after the death of the animal. Where its dorsoventral diameter is 12.8 mm., its lateral one is 10.2 mm. Moreover, in its present condition at least, the conch is slightly curved lengthwise, that outline toward which the annulations rise having a convexity of 1.5 mm. in a length of 55 mm. This convex outline here is assumed to be ventral. A few obscure vertical lines below the break near the lower end of the specimen suggest *Spyroceras*, rather than *Cycloceras*, as the generic relationship of this conch.

Occurrence.—Cannon Falls, Goodhue county, Minnesota; in the Platteville member of the Black River formation. No. 4119, in the Scofield collection, in the museum of the Univ. of Minnesota.

30. **Spyroceras** cf. **lesueuri** (Clarke)

Plate 12, fig. 9

Orthoceras lesueuri Clarke, Geol. Minnesota, *3*, pt. 2, 785, pl. 55, fig. 8 (1897).

This specimen was figured by Clarke under the name *Orthoceras lesueuri* but the conch shows no indication of lengthwise curvature and its annulations are directly transverse.

The specimen is 49 mm. long, and is distinctly septate for a length of 13.5 mm. at its base, this length being occupied by 5 camerae. The lateral diameter enlarges from 14.1 mm. at its base to 15.8 mm. at a point 19 mm. farther up, and then diminishes to 15 mm. at a height of 29 mm., and to 14 mm. at 38 mm. This narrowing of the upper part of the living chamber is relatively common among annulated orthoconic nautiloid genera, such as *Spyroceras, Cycloceras,* and *Dawsonoceras.* The concavity of the septum at the base of the specimen is 2 mm. The location of the siphuncle apparently is central. The surface of the shell is annulated, 6.5 annulations occurring in a length equal to the lateral diameter of the conch. These annulations slope faintly downward in a ventrad direction, the ventral outline of the conch being slightly convex along the lower part of the specimen, but more strongly convex toward its top. The crests of the annulations rise fully 0.5 mm. above the intervening grooves. The surface of the shell is not preserved, so that nothing is known of its surface ornamentation. Hence, the reference of this specimen to *Spyroceras* is merely tentative, and is based upon a supposed relationship to typical *Spyroceras lesueuri* (Clarke).

Occurrence.—Dixon, Illinois; in the Platteville member of the Black River formation. No. 46528, U. S. National Museum.

31. **Spyroceras paquettense** Sp. nov.

Plate 12, fig. 10

Conch closely resembling *Spyroceras anellus* (Hall),[4] from the Black River formation at Mineral Point, Wisconsin, in the prominence and relative number of its annulations, and apparently also in the minute vertical striation of its surface, but differing in its rate of enlargement at an angle of fully 6 degrees, instead of only 3.5 degrees. Whether this difference in rate of enlargment is a sufficiently constant feature can be determined only in the pres-

[4] Foerste, Aug. F., Jour. Sci, Lab. Denison Univ., *23,* 177, pl. 40, fig. 4 (1928).

ence of additional material, but, as far as known at present, the species here described is distinct.

Specimen 44 mm. long, enlarging from a diameter of 10.5 mm. at its base to 14.2 mm. at a point 39 mm. farther up. Its surface is sharply and prominently annulated. The number of annulations in a length equal to the diameter of the conch increased from 6 along its lower part to nearly 7 at its top. At its upper end the annulations are fully 1 mm. in height and their crests are narrowly rounded. At mid-length of the specimen there are traces of vertical striae, alternating somewhat in size, occurring at the rate of about 7 in a width of 2 mm. Along the entire length of the specimen the sutures of the septa occur at the bottom of the grooves between the annulations. The annulations slope downward in a direction assumed to be dorsad at an angle of about 3 degrees with the horizontal. The concavity of the septum of the top of the specimen is 1.5 mm. The center of the siphuncle here is slightly nearer the supposed ventral side of the conch. At the base of the specimen, where its diameter is 10 mm., the center of this siphuncle is 3.5 mm. from its ventral margin, being distinctly nearer the latter here than at the top. Its diameter at the septal neck is 1 mm. at the top of the specimen. Its segments appear to enlarge moderately within the camerae.

In a second specimen, 15 mm. long and 11 mm. in diameter at its larger end, 7 vertical striae occur in a width of 1 mm.

Occurrence.—Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 6831, National Museum of Canada.

32. **Spyroceras scofieldi** Sp. nov.

Plate 23, figs. 5A, B

Orthoceras lesueuri Clarke, Geol. Minnesota, *3*, pt. 2, pl. 53, fig. 4 (1897).

This specimen came from the same locality and horizon as the holotype of *Spyroceras lesueuri* (Clarke), but is not mentioned in the text. It consists apparently of a living chamber contracting toward its top, no trace of a suture of a septum being preserved.

It is included in the upper end of the endocone of some species of *Endoceras*. The specimen is 20 mm. long, circular in cross-section, and contracts from a diameter of 14 mm. at its lower end to 12.5 mm. at its top. The outline assumed to be dorsal is straight, while the supposed ventral outline is slightly convex. At the base of the specimen the lowest annulation rises in a dorsad direction at an angle of 18 degrees with the horizontal, the second annulation rises at an angle of 14 degrees, and the uppermost or ninth annulation at an angle of 7 degrees. The annulations, therefore, converge in a dorsad direction. Along the ventral outline of the conch the two lower annulations are 2.5 mm. apart, the next three intervals being 2 mm., and the next three are successively shorter, the upper one of these three equalling 1.5 mm. in length. These are followed by two intervals of which the first is 3 mm. long, and the second or last is 3.5 mm. The conspicuously increased length of the last two intervals suggests gerontic conditions at the top of the living chamber, such as occur in other annulated orthoconic nautiloids. The annulations are low, scarcely over one-tenth of a millimeter in height, but distinct. A fragment of the shell 4 mm. long and 3 mm. wide is preserved and shows very narrow but distinct vertical raised lines, about 7 in a width of 1 mm., alternating with an equal number of finer ones, both sets crossed by much finer transverse lines, about 15 in a length of 1 mm.

Occurrence.—Cannon Falls, Goodhue county, Minnesota; in the Platteville member of the Black River formation. No. 4118, in the Scofield collection, in the museum of the Univ. of Minnesota.

Remarks.—By Clarke this specimen was figured under the name *Orthoceras lesueuri*. However, its annulations are less prominent, and they slope downward toward the convex side of the conch, instead of rising in that direction. This downward slope of the annulations in a ventrad direction, along the living chamber, distinguishes this specimen also from the group here included in *Metaspyroceras*. Apparently it belongs to an unnamed generic type regarding which too little is known to make the specimen available as a genotype.

33. **Spyroceras perroti** (Clarke)

Plate 15, fig. 5

Orthoceras perroti Clarke, Geol. Minnesota, *3*, pt. 2, 785, pl. 54, figs. 4, 5 (1897).

Specimen 49 mm. long, enlarging from a maximum diameter of 24 mm. at its base to 29 mm. at a point 39 mm. farther up, indicating an apical angle of 7 degrees in that direction. The corresponding minimum diameters are 20 mm. and 26 mm., the conch probably having been compressed by pressure after the death of the animal. The concavity of the septum at the top of the specimen is between 4 and 5 mm. The passage of the siphuncle through this septum is about 1.75 mm. in diameter, and its location is central. The surface of the conch is strongly annulated with only a slight downward slant in the direction of the shorter diameter. Nearly 8 annulations occur in a length equal to the longer diameter of the conch at the top of the series counted. The crests of these annulations rise about 1 mm. above the intervening grooves. These crests are distinctly rounded and are about as broad as the intervening grooves. In addition there are 32 vertical primary ribs alternating with an equal number of secondary ones. Both sets of ribs are sharp and narrow, extending above the general level of the surface of the shell like vertical lamellae projecting radially outward. These lamellae are taller over the crest of the annulations than along the intervening grooves, reaching a maximum of three-fourths of a millimeter on the crests. The secondary lamellae are distinctly less prominent, apparently extending outward only slightly more than a quarter of a millimeter. There are also traces of transverse striae, about 4 in a length of 1 mm.

Occurrence.—Granger, Minnesota; in the Maquoketa member of the Richmond. No. 4128, in the Museum of the University of Minnesota.

Remarks.—The lamellose outward extension of the primary vertical ribs on the surface of the shell of this species is more conspicuous than in any other species of this genus known.

34. **Spyroceras mcfarlani** Sp. nov.

Plate 14, fig. 5

Specimen 130 mm. long, enlarging from a lateral diameter of 29.5 mm. to 36 mm. in a length of 57 mm., suggesting an angle of enlargement of almost 4 degrees. Its cross-section appears to be circular. Its supposed dorsal outline is straight and the sutures of the septa rise slightly toward this outline, while the annulations curve distinctly downward where crossing the dorsal side of the conch, as in typical *Metaspyroceras*. However, its ventral outline is not preserved, so that it can not be determined whether the supposed ventral outline is convex, nor whether the living chamber contracts toward the aperture. The number of camerae in a length equal to the lateral diameter of the conch equals between 11 and 12. The sutures of the septa rise in a dorsad direction at an angle of 5 to 8 degrees. The number of annulations in a length equal to the lateral diameter of the conch varies from eight to eight and a half along the phragmacone, the latter being 75 mm. long. Along the living chamber, of which a length of nearly 55 mm. is preserved, these annulations are less distinctly marked. Along the phragmacone the annulations are about one-third of a millimeter in height and are fully as broad as the intervening grooves. The surface of the shell is marked by 26 vertical primary ribs, about half a millimeter in width. The intervening spaces are relatively flat, and are marked by 5 to 7 vertical raised lines almost equal in size but with the median one slightly more prominent. The transverse striae are weakly defined, are virtually absent along most of the specimen, but at its base number about 8 in a length of 2 mm.

Occurrence.—Two miles south of Crow distillery, 7 miles south of Frankfort, Kentucky; from the Perryville member of the Trenton formation. No. 87115, U. S. National Museum. Named in honor of Prof. Arthur C. McFarlan.

Remarks.—Compared with *Spyroceras frankfortense* Foerste (Denison Univ. Bull., *16*, pl. 1, figs. 1 A, B (1910)), *Spyroceras mcfarlani* has more numerous annulations in a length equal to the

diameter of the conch, and the vertical striae between the primary ribs are less conspicuous and more nearly equal is size. Eventually this conch may prove to belong to *Metaspyroceras*.

Spyroceras gorbyi (Miller), from the Whitewater member of the Richmond (Foerste, Jour. Sci. Lab. Denison Univ. *23*, pl. 61, figs. 4 A-C (1928)) appears to belong to a distinct group. The sutures of its septa are directly transverse. The annulations rise strongly toward one side of the conch, but they appear to be confined to one side of the conch, becoming obsolete toward the other.

35. **Spyroceras beauportense** (Whiteaves)

Plate 13, figs. 1A, B

Orthoceras beauportense Whiteaves, Ottawa Naturalist, *12*, 118 (1898).

Spyroceras beauportense Whiteaves, Geol. Surv. Canada, Pal. Foss., *3*, pt. 4, 323, pl. 33, figs. 2, 2a (1906).

Holotype 52 mm. long, evidently compressed by pressure previous to fossilization. In its present condition its maximum diameter enlarges from 9.6 mm. at its base to 11 mm. at a point 47 mm. farther up, indicating an apical angle of about 1.7 degrees. At the top of the specimen the shorter diameter is about 8.5 mm. The free edge of the specimen, on its right side as figured, appears slightly convex in outline, but its opposite side is straight, the curvature of the former resulting apparently from the pressure mentioned above. No trace of the septa or siphuncle is preserved. The surface of the shell is ornamented by 21 conspicuous vertical ribs, from 0.3 to 0.4 mm. in width, with crests about 1.7 mm. apart. These are crossed by transverse annulations numbering 5 in a length of 11 mm., and therefore are about 2.75 mm. apart. The annulations are only from 0.25 to 0.3 mm. in height above the intervening grooves, but are relatively broad in a vertical direction, slightly exceeding 1 mm. in width. In addition there are sharply defined transverse raised lines, numbering from 9 to 11 in a length of 2 mm.

Occurrence.—Parent's quarry, Beauport, about 3 miles northeast of Quebec City, Canada; in the Trenton limestone. No. 4413, in the National Museum of Canada.

Remarks.—*Spyroceras beauportense* belongs to the group of species, including *Spyroceras clathratum* (Hall), in which the vertical ribs are relatively distant from each other and in which the transverse striae are sufficiently prominent to produce a sort of ladder-like effect, on a minute scale, in the spaces between the the vertical ribs.

36. **Spyroceras whitcombi** Sp. nov.

Plate 13, figs. 2A, B, C

Holotype 32 mm. long, moderately compressed by pressure previous to fossilization. Shorter diameter 6 mm.; larger diameter estimated at 8 or 9 mm. Rate of enlargement evidently small, since no enlargement can be detected in the length preserved. Conch transversely annulated, the number of annulations varying from 4 to 5.3 in a length of 9 mm. These annulations are distinct, but low and broad, not rising over one-fifth of a millimeter above the intervening transverse grooves, nor exceeding three-fourths of a millimeter in width. In addition, the surface of the conch is ornamented by conspicuous vertical ribs and inconspicuous transverse raised lines. Apparently about 22 ribs occur within the circumference of the conch. The transverse lines number about 7 or 8 in a length of 1 mm. They are relatively coarse and fully as wide as the intervening grooves, but can not be seen readily without a lens. About 5 or 6 of these lines occur on the annulations and about 12 in the intermediate spaces. The crests of the ribs are fully one-fourth of a millimeter wide, but there are no intermediate vertical striae. Neither of the two specimens at hand presents any trace of sutures, septa, or siphuncle.

Occurrence.—Bellefonte, Pennsylvania; in the Salona formation, immediately beneath the base of the typical Trenton, as identified in central Pennsylvania. Collected by Lawrence Whitcomb.

Remarks.—This specimen is of special interest on account of its close relationship with *Spyroceras beauportense*, from the Trenton of Beauport, several miles northeast of the city of Quebec. Compared with that species, *Spyroceras whitcombi* appears to be a

smaller form, with fewer annulations in a length equal to the diameter of the conch, but with relatively more numerous transverse raised lines, especially in the grooves between the annulations. The number of vertical ribs within the circumference of the conch, and their relative prominence is very similar to that of the Quebec species.

Compared with the type of *Spyroceras clathratum* (Hall), from the Trenton at Middleville, New York, the number of annulations in the Bellefonte specimen here described, in a length equal to the diameter of the conch, and the number of transverse lines in a length of 1 mm. are the same. However, in the New York species there are about 40 vertical ribs within the circumference of the conch, and the transverse raised lines are distinctly narrower than the intervening transverse grooves. Moreover, the New York species enlarges from 5.6 mm. to 6.6 mm. in diameter in a length of 9 mm., indicating an apical angle of 6.5 degrees, while the Bellefonte specimen is more nearly cylindrical in form.

37. **Spyroceras** (?) **romingeri** Sp. nov.

Plate 16, figs. 3A, B

Specimen 36 mm. long, its straight outline assumed to be dorsal, its ventral outline faintly concave up to a height of 17 mm. above its base, and then more or less gibbous along its upper part. Assumed to consist of the upper part of the phragmacone and the lower part of the living chamber. Its dorsoventral diameter enlarges from 7.3 mm. at 4 mm. above its base to 11 mm. at a point 25 mm. farther up, the corresponding lateral diameters being 7.5 mm. and 11 mm. Above this level of 25 mm. the conch apparently contracted slightly, at least dorsoventrally. Where broken across at midlength, the specimen preserves no trace of septa. The shell is thin, and its surface is both vertically striated and transversely wrinkled and striated. The number of more prominent vertical striae is about 40, with one area along the median part of the ventral side and another along one of the ventrolateral sides where there are no prominent vertical striae but where there is room for 5 more. In addition there are a few intermediate striae between several of the primary ones. The transverse striae

are almost directly transverse dorsally and dorsolaterally, but ventrally they curve distinctly downward. The transverse wrinkles are virtually obsolete dorsally, but laterally and ventrally are fairly distinct, especially along the more gibbous part of the conch, and here they are parallel to the transverse striae. There are about 6.5 transverse wrinkles in a length of 11 mm. along this more gibbous part of the conch.

Occurrence.—St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Holotype, no. 14427, Univ. of Michigan.

Remarks.—In the absence of any knowledge of the septa or siphuncle, the relationship of this specimen remains uncertain. It differs from *Metaspyroceras* in the downward curvature of the annulations on the ventral side of the conch.

METASPYROCERAS Gen. nov.

Genotype.—*Spyroceras ruedemanni* Foerste, Jour. Sci. Lab. Denison Univ. *23*, 281, pl. 61, figs. 3 A-G (1928).

Relatively short conchs, usually depressed dorsoventrally, with the dorsal outline nearly straight, but the ventral outline more or less distinctly convex. The sutures of the septa tend to slope downward in a ventrad direction, while the annulations rise in that direction, especially toward the top of the conch. As in other spyroceroids, the annulations tend to become more distant from each other at gerontic stages of growth. Also, the exterior of the shell is vertically ribbed or striated, the vertical markings often alternating in prominence. The tendency toward a more or less distinctly convex ventral outline is their most distinctive feature.

The species described by Clarke as *Orthoceras nicolleti*, though tentatively referred to *Metaspyroceras*, probably belongs to some undescribed cyrtoconic or gyroceraconic genus, of which the more strongly curved part is unknown.

Spyroceras geronticum Foerste (Jour. Sci. Labs. Denison Univ. *22*, 38, pl. 6, figs. 1A, B (1927)) shows a similar tendency toward a nearly straight dorsal outline, with a distinctly curved ventral outline. The annulations rise at an increased rate in a ventral

direction on proceeding from the top of the phragmacone to the top of the living chamber, but the sutures of the septa are directly transverse to the length of the conch.

Spyroceras anticostiense Foerste (Memoir 154, Geol. Surv. Canada, 277, pl. 37, fig. 4 (1928)) shows a tendency toward a convex ventral outline, but both the sutures of the septa and the crests of the annulations are directly transverse.

Possibly *Spyroceras teretiforme* (Hall) belongs to the *Metaspyroceras* group. Its ventral outline is slightly convex, and its annulations rise at an increasing rate in a ventrad direction on approaching the top of the living chamber, but the sutures of its septa appear to be directly transverse.

38. **Metaspyroceras minneapolis** Sp. nov.

Plate 24, figs. 3A, B

Orthoceras bilineatum Clarke, Geol. Minnesota, *3*, pt. 2, 786, pl. 54, figs. 6, 7 (1897).

Specimen 54 mm. long, 21 mm. of this length belonging to the living chamber. The dorsal outline of the conch is almost straight or only faintly convex; its ventral outline, on the contrary, has a distinct convexity, with a radius of curvature of 120 mm. Its lateral diameter is estimated at 12.5 mm. at the base of the specimen, increasing to 24 mm. at 6 and 10 mm. above the base of the living chamber, and then narrowing toward the aperture. Its dorsoventral diameter increases from 10.8 mm. at the base of the specimen to 15 mm. at a point 4 mm. beneath the base of the living chamber, and it continues at this diameter to about 6 mm. above the base of that chamber, above which it probably contracted more or less. The number of camerae in a length equal to the lateral diameter of the conch equals 6 along the lower part of the specimen, increasing to 6.5 along the upper part of the phragmacone, the uppermost camera being distinctly shorter than those immediately beneath, indicating that the conch had reached full maturity. The sutures of the septa slope downward in a ventrad direction at an angle of 10 degrees with the horizontal. The annulations, on the contrary, rise in a ventrad direction. At the base of the specimen this rise equals only 2 degrees above the

horizontal; but along the upper part of the phragmacone and along the entire length of the living chamber it equals 5 degrees. Along the living chamber these annulations rise only about half a millimeter above the intervening grooves. Along the phragmacone their elevation is slightly less. Faint traces of vertical raised lines are present, but these are preserved much better in the second specimen figured by Clarke. The one just described is numbered 381, and is the original of Clarke's figure 7, on his plate 54, cited above. Plate 24, fig. 3A.

The second specimen figured by Clarke on his plate 54 (fig. 6) is 66 mm. long, 29 mm. of this length belonging to the living chamber. Its lateral diameter attains a maximum of 20 mm. at the second and third annulation above the base of this chamber. Farther up, it appears to contract slightly toward the aperture. The number of camerae along a length equal to the lateral diameter equals 4 along the lower part of the specimen, increasing to 5 along the upper part of the phragmacone. The sutures of the septa slope downward in a ventrad direction, and the annulations in a dorsad direction, as in the preceding specimen. Along the lower half of the specimen, primary vertical ribs alternate with an equal number of secondary ones, 7 primary ribs occurring in a width of 5 mm. where the lateral diameter of the conch is 15 mm. At the top of the phragmacone, where the lateral diameter is 19 mm., there are enough vertical lines to suggest the presence of tertiary as well as secondary and primary ribs and lines, but they are so nearly equal in prominence locally that they can not readily be differentiated, especially in the case of primary and secondary ones. The transverse lines number 5 in a length of 1 mm. The concavity of the septa equals about 3 mm. The segments of the siphuncle appear to enlarge within the camerae, as in *Sactoceras*. No. 350, in the Museum of the Univ. of Minnesota. Plate 24, fig. 3B.

Occurrence.—Minneapolis, Minnesota; from the Decorah member of the Black River formation. Both specimens are in the Museum of the Univ. of Minnesota.

Remarks.—This species closely resembles *Metaspyroceras ruedemanni* Foerste, from the Cedarville dolomite at Wilmington,

Ohio, in the course of the sutures of its septa and of its annulations. No exact comparison can be made with *Spyroceras bilineatum* Hall, in the present state of our knowledge of that species, the types consisting of small fragments, without any trace of the sutures of the septa.

39. **Metaspyroceras rideauense** Sp. nov.

Plate 24, figs. 4A, B

Specimen 45 mm. long, its upper part, for a length of 20 mm., belonging to the living chamber. The conch is compressed dorsoventrally. At the base of the living chamber its dorsoventral diameter is 16 mm. and its lateral one is estimated at 18 mm. Farther up, for a length of 15 mm., this chamber contracts slightly. Near the aperture it may enlarge slightly. The sutures of the septa slant downward, in a direction assumed to be ventrad, at an angle of 10 degrees with the horizontal. The upper 12 camerae occupy a total length of 13.2 mm. along the ventrolateral side of the conch, averaging at a length of 1.1 mm. for each camera. However, the single camera immediately beneath this series is 2.1 mm. long, so that this may be the normal length of the upper camerae of the phragmacone, while the overlying camerae represent gerontic retardations of growth. The annulations are nearly horizontal, rising slightly in a ventrad direction. They number 5 in a length equal to the lateral diameter of the conch. The specimen is a cast of the interior of the conch. Its surface shows 9 vertical ribs in a width of 10 mm. A small fragment of the shell, retained at the base of the specimen, shows a faint trace of a single secondary rib in each groove between the primary ribs. No transverse striae can be detected.

Occurrence.—South of Ottawa, Ontario, Canada; on the right bank of the Rideau river, below the entrance of the Rideau canal, at Hogs Back; in the Chazy formation. No. 6832, in the National Museum of Canada.

Remarks.—This species evidently is similar to *Metaspyroceras minneapolis* and *Metaspyroceras ruedemanni*. From the former it differs in the relatively greater distance between its annulations

along the upper part of the phragmacone, and in their smaller rise in a ventrad direction. The numerous short camerae at the top of the phragmacone are regarded as characteristic of this single individual, but not of the species as a whole.

40. **Metaspyroceras** (?) **wisconsinense** Sp. nov.

Plate 24, fig. 6

Specimen 47 mm. long, strongly flattened by pressure. In its present condition its maximum diameter diminishes from 18.1 mm. along the lower part of the specimen to 11.3 mm. at the annulation 10 mm. below its top. The interval between the lowest two clearly defined annulations is 4 mm., the overlying two intervals averaging about 4.5 mm. each, the following ones equalling about 5 mm. each. Owing to the narrowing of the conch toward its top, the ratio between the number of annulations and the diameter of the conch becomes distinctly less toward the top of the living chamber. The crests of these annulations are broadly rounded, but are narrower than the intervening grooves; they rise about 1 mm. above the base of the latter. The surface of the shell is marked by about 16 primary vertical ribs alternating with an equal number of secondary ribs, both alternating with 32 tertiary vertical striae, the total number of these vertical markings being about 64. Along the lower part of the specimen, where these vertical lines are most distant from each other, 6 primary and secondary ribs occur in a width of 4 mm. All vertical markings are crossed by transverse lines, the latter numbering 13 in a length of 4 mm. All of the vertical lines are distinct, especially the primary ones. The transverse lines are about as distinct as those of *Spyroceras clathratum*.

Occurrence.—Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 8292, in the museum of the Univ. of Minnesota.

Remarks.—This is the specimen cited by Clarke under the name *Orthoceras olorus*. Apparently it formed the basis of that part of his description which states that the annulations are slightly undulating and are traversed by alternating elevated vertical striae

and these are crossed by extremely fine horizontal lines. At least, none of the other specimens referred by him to *Orthoceras olorus* in the Minnesota collection show this surface ornamentation. Compared with typical *Spyroceras olorus*, the transverse striae of the Wisconsin form here described are much stronger and less numerous. Compared with typical *Spyroceras clathratum*, the vertical ribs and striae are more numerous and differ more in prominence among each other, but the transverse striae are closely similar, though numbering only about 4 in a length of 1 mm.

The reference of *Metaspyroceras wisconsinense* to *Metaspyroceras* is based chiefly on the increased rise of the annulations in a ventrad direction on approaching the top of the living chamber. In the absence of any knowledge of the sutures of the septa, it can not be determined whether these sutures slope in an opposite direction as in the genotype.

41. **Metaspyroceras perlineatum** Sp. nov.

Plate 24, figs. 5A, B

Specimen 16.5 mm. long, enlarging from a lateral diameter of 12 mm. to 14 mm. in a distance of 13 mm., the angle of enlargement in this direction being 9 degrees. Four camerae occupy a total length of 13.5 mm., equivalent to almost 5 camerae in a length equal to the maximum diameter of the conch. The dorsoventral diameter at its top is 13 mm. The sutures of the septa slope downward at an angle of 3 degrees in a ventrad direction. The concavity of the septum at its lower end is 2 mm.; here the siphuncle is central in location, and its passage through the septum is 1 mm. in diameter. The transverse annulations number 6 in a length of 12 mm., which is equivalent to 8 in a length equal to the lateral diameter. The annulations rise in a ventrad direction, the amount of this rise increasing toward the upper end of the specimen, where it equals 8 degrees with the horizontal. The annulations are low, about one-fifth of a millimeter in diameter, and are of about the same width as the intermediate grooves. The surface of the shell is vertically striated, 10 or 11

striae occupying a width of 2 mm., all apparently equal in prominence.

Occurrence.—St. Paul, Minnesota, at the Ford plant; in the Decorah member of the Black River formation. No. 4130, Univ. of Minnesota.

42. **Metaspyroceras clarkei** Sp. nov.

Plate 13, figs. 3A, B; 5, 6

Orthoceras bilineatum Clarke, Geol. Minnesota, *3*, pt. 2, 787, pl. 47, fig. 20 (1897).

Holotype 45 mm. long, with its dorsal outline nearly straight along the phragmacone, but faintly convex along the living chamber. Its ventral outline is faintly convex along the upper half of the phragmacone. Laterally it enlarges from a diameter of 7 mm. at its base to 12 mm. at the top of the phragmacone, and above this level it either retains about the same diameter or contracts a little. The dorsoventral diameter enlarges from 6.6 mm. at its base to 11 mm. at the top of the phragmacone, above which its ventral outline is not preserved. The number of camerae in a length equal to the lateral diameter of the conch decreases from 7 along the lower end of the phragmacone to 5.7 along its upper part. The uppermost camera is only 1 mm. long, the one immediately beneath measuring 2 mm., thus suggesting that the conch was fully mature. The sutures of the septa curve downward along the median part of the ventral side of the conch, forming shallow ventral lobes. Along the surface of the phragmacone the surface of the shell is ornamented by 21 prominent primary vertical ribs, alternating with an equal number of much less prominent secondary ones; in addition to which there are about 42 tertiary raised lines, alternating with the preceding primary and secondary ribs, and visible only under a lens. All of these are crossed by very fine horizontal lines, between 5 and 6 in a length of 1 mm., also visible only under a lens. Along the living chamber the primary vertical ribs become much less prominent, so as to be only slightly more distinct than the secondary ones, and the transverse lines here become more crowded, about 8 occurring in a

length of 1 mm. In addition to these vertical and transverse lines the conch also is annulated, the annulations being confined to the upper part of the phragmacone and the entire length of the living chamber. These annulations rise in a ventrad direction at an angle of 5 degrees with the horizontal. The upper 5 annulations are relatively more prominent and occupy a total length equal to the lateral diameter of the conch at the base of the living chamber. The immediately underlying annulation is much less prominent, and the 3 immediately beneath are successively fainter. Below this lower group of three no distinct annulations can be detected. At the base of the specimen, where its dorsoventral diameter is 6.2 mm., the center of the siphuncle is 3.6 mm. from the ventral wall of the conch, the passage of the siphuncle through the septum here being 0.9 mm. in diameter. The concavity of this septum is 1.1 mm. Plate 13, figs. 3A, B.

Occurrence.—Minneapolis, Minnesota; in the Decorah member of the Black River formation. Holotype, no. 5042, museum of Univ. of Minnesota. Original of Clarke's fig. 20, pl. 47, cited above.

Remarks.—In the convex outline of the ventral side of the conch, the downward curvature of the sutures of the septa in a ventrad direction, and the rise of the annulations in a ventrad direction this species resembles typical *Metaspyroceras*. Apparently it originated from a form which in its earlier stages of development closely resembled a typical *Kionoceras*. This can not be asserted of the other species here referred to *Metaspyroceras*.

One of the specimens found at the Ford plant, at St. Paul, Minnesota, may represent a young stage of the same species. It is 43 mm. long, 10.1 mm. wide at its top, and 9 mm. in diameter dorsoventrally. Both the vertical and transverse markings are well shown. Plate 13, fig. 5. No. 4129, Univ. of Minnesota.

The small specimen represented by fig. 21 on Clarke's plate 47, cited above, may belong to the same species. This fragment is 21 mm. long, has about 22 or 23 vertical ribs, is slightly annulated along the lower 6 mm. of its length, but shows no distinct evidence of annulation farther up. It is transversely striated. Plate 13. fig. 6. No. 8284, Univ. of Minnesota.

43. **Metaspyroceras** cf. **clarkei** Foerste

Plate 13, fig. 4

Associated with other specimens from the Ford plant, at St. Paul, which might be regarded as the young of typical *Metaspyroceras clarkei*, there are several individuals which are annulated at a much younger stage than in the holotype of *Metaspyroceras clarkei*. The specimen here figured is 27 mm. long and 7 mm. wide at its top. The annulations are about as numerous as the camerae. It is impossible to determine from the small number of specimens at hand whether these small annulated fragments are to be regarded as belonging to a distinct species.

Occurrence.—Ford plant, St. Paul, Minnesota; in the Decorah member of the Black River formation. No. 4131, Univ. of Minnesota.

44. **Metaspyroceras** (?) **nicolleti** (Clarke)

Plate 11, fig. 1

Orthoceras nicolleti Clarke, Geol. Minnesota, *3*, pt. 2, 784, pl. 55, figs. 1, 2 (1897).

Specimen 155 mm. long, distinctly curved lengthwise, arching convexly along its ventral side for a distance of 8 mm. in a length of 140 mm., the corresponding curvature of its concave dorsal outline being 4 mm. The dorsoventral diameter of the conch, measured parallel to the crests of its conspicuous annulations, increases from 33 mm. at its lowest annulation to 37.5 mm. at the fifth annulation, and decreases again to 36.5 mm. at the uppermost one. The cross-section of the conch appears to have been either circular or slightly flattened laterally. About 2.5 annulations occur in a length equal to the dorsoventral diameter of the conch, when counted along its ventral outline. The annulations are relatively narrow, compared with the intervening grooves, the latter being almost 3 mm. in depth. At the base of the specimen the annulation slopes downward in a dorsad direction at an angle of 6 degrees with the directly transverse plane, changing to 10 degrees at the sixth annulation, and to 14 degrees at its top. The septum at the base of the specimen has a concavity of 8 mm.

Its suture slopes downward in a ventrad direction at an angle of 5 degrees with the horizontal, being more distant from the crest of the underlying annulation ventrally. Several of the overlying annulations may belong to the phragmacone, but the limiting septa are not clearly defined. No trace of surface ornamentation remains. The siphuncle is located centrally and appears to be about 4 or 5 mm. in diameter at its passage through the septum at the base of the specimen, but its boundaries are but vaguely indicated.

Occurrence.—Belle Creek, Minnesota; in the Platteville member of the Black River formation. No. 4124, in the Scofield collection, in the museum of the University of Minnesota.

Remarks.—In the absence of any trace of surface markings it is impossible to determine whether the affinities of this specimen are with *Cycloceras* or *Spyroceras*. It is here placed tentatively in *Metaspyroceras* owing to the increasing rise of the annulations in a ventrad direction on approaching the top of the living chamber. The lower part of the specimen, for a length of 60 mm., belongs to the phragmacone, traces of a septum appearing at each of the lower five annulations on the weathered dorsolateral side of the conch. The distinct lengthwise curvature of the conch, dorsally as well as ventrally, is anomalous among typical spyroceroids, and suggests that the fragment at hand may be the relatively straight part of some conch which toward its apical end was much more strongly coiled.

MURRAYOCERAS Foerste

Genotype.—*Orthoceras murrayi* Billings, Geol. Surv. Canada, Rept. of Progress for 1853–56, 332 (1857). *Murrayoceras murrayi* Foerste, Jour. Sci. Lab. Denison Univ., *21*, 312 (1926); *23*, 314, pl. 75, fig. 5 (1928).

Conch strongly depressed dorsoventrally, the ventral side distinctly flattened, the dorsal side usually broadly and evenly rounded, but sometimes sufficiently flattened dorsolaterally to be slightly angular alongs its median part. Sutures of septa curving downward ventrally. Siphuncle located near the ventral wall of the conch, relatively large. Septal necks vertical, not

curving outward at their base. Connecting rings usually expanding slightly within the camerae, but slightly contracting in the specimen figured by Foord.

Garryoceras semiplanatum (Whiteaves) presents a similar appearance exteriorly, but its siphuncle is smaller and is located near the convexly curved side of the conch. The segments of the siphuncle apparently are cylindrical.

45. **Murrayoceras murrayi** (Billings)

Plate 21, figs. 1A, B; 3A, B, C; 2

Orthoceras murrayi Billings, Geol. Surv. Canada, Rep. Progress for 1853–56, 332 (1857).

Jovellania murrayi Foord, Cat. Foss. Cephalopoda in Brit. Mus., *1*, 328, text-figs. 50a-c (1888).

Murrayoceras murrayi Foerste, Jour. Sci. Lab. Denison Univ., *21*, 312 (1926); *23*, 314, pl. 75, fig. 5 (1928); *24*, 167, pl. 16, fig. 5 (1929).

Specimen 96 mm. long, enlarging at an angle of 8 degrees from a lateral diameter of 23 mm. at its base to 34.5 mm. at a point 80 mm. farther up, its corresponding dorsoventral diameters being 17 mm. and 25.5 mm. Its cross-section along the upper end of the specimen has a radius of convex curvature of about 18 mm. dorsally, 10 mm. laterally, and 30 mm. ventrally. The number of camerae in a length equal to the lateral diameter of the conch varies from 10 along the lower end of the specimen to 13 near its upper end. The sutures of the septa are directly transverse dorsally and laterally, but ventrally they curve downward about 4 mm. at mid-length of the specimen, and 4.5 mm. near its top. At the base of the specimen the siphuncle is 4.5 mm. in diameter, and its center is estimated at 1.5 mm. from the ventral wall of the conch. Plate 21, figs. 1A, B.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Specimen no. 7512, in the museum of the University of Michigan.

Remarks.—Compared with the specimen figured by Foord from the same locality and horizon, the apical angle of the

specimen here described is larger, and the cross-section is less triangular, its dorsolateral sides not being flattened. In consequence, the sutures of the septa do not curve downward dorsolaterally, as in Foord's specimen. Moreover, along the ventrolateral sides of the conch the sutures of the septa do not curve downward until nearer the flattened part of the ventral side. In consequence the downward curvature of the sutures along this ventral side is more conspicuous.

Another specimen from St. Joseph Island, numbered 13404 in the museum of the University of Michigan, is 87 mm. long and enlarges in lateral diameter from 14 mm. at its base to 22.5 mm. at a point 60 mm. farther up. Where its lateral diameter is 16 mm., that of the siphuncle is 3.6 mm., the septal necks are nearly half a millimeter long, and the connecting rings enlarge distinctly within the camerae, reaching their maximum diameter a little above mid-height of the latter. Plate 21, figs. 3A, B, C.

A fragment of a large specimen, 60 mm. long, was found in lot 4, concession 3, of Gloucester township, Carleton county, southeast of Ottawa, Canada, in the Black River formation. It retains 35 mm. of the lower part of the living chamber and parts of 7 camerae having a total length of 23 mm. laterally. At the base of the living chamber this specimen is 43 mm. wide laterally, and 32 mm. dorsoventrally. It is more nearly subtriangular than the specimen here described first, and the sutures of the septa appear to curve downward slightly dorsolaterally. Plate 21, fig. 2. No. 6833, in the National Museum of Canada.

46. **Murrayoceras carletonense** Sp. nov.

Plate 21, figs. 4A, B

In *Murrayoceras murrayi* Billings the sutures of the septa are directly transverse laterally and dorsally, but curve broadly and distinctly downward ventrally. In the single specimen here described the sutures curve down ventrally, as in the species named, but laterally and dorsally they rise in a dorsad direction at an angle of about 8 degrees with the horizontal, and this is its chief distinguishing feature.

Holotype 75 mm. long, enlarging laterally from a diameter of 24.5 mm. at its base to 31 mm. near its top. At its upper end its dorsoventral diameter is estimated at 25.5 mm. The number of camerae in a length equal to the lateral diameter of the conch increases from 9 along the lower part of the specimen to 10 at its top. At its upper end the siphuncle is 6 mm. in diameter laterally and 5 mm. dorsoventrally, its distance from the ventral wall of the conch being estimated at 4 mm. Where the lateral diameter of the conch is about 24 mm., the lateral diameter of the siphuncle is 5 mm., the concavity of the septa is at least 3.5 mm., the septal necks are one-third of a millimeter long, and the connecting rings expand slightly along their upper two-fifths, contracting toward their base where they invaginate slightly into the top of the septal neck immediately beneath.

Occurrence.—Lot 4, concession 3, in Gloucester township, Carleton county, southeast of Ottawa, Ontario, Canada. Holotype, no. 6834, in the National Museum of Canada.

ALLUMETTOCERAS Foerste

Genotype.—*Tripteroceras paquettense* Foerste, Jour. Sci. Lab. Denison Univ., *20*, 233, pl. 31, figs. 2A–D (not figs. 3A–D, which illustrate *Tripteroceras hastatum* Billings) (1924); *21*, 311 (1926).

Cross-section similar to that of *Tripteroceras*, but less compressed dorsoventrally; lateral sides much more broadly rounded, with no tendency toward angularity along the median part of the dorsal side; ventral side flattened, but not for as great a width. In the type species the siphuncle is relatively large, and its segments are nummuloidal, somewhat as in *Ormoceras* in general form. However, these segments appear to be in contact both with the septa above and beneath. Where the passage of the siphuncle through the septum is 1.5 mm. in diameter, the area of contact has a diameter of 4 mm., and from this diameter the connecting rings enlarge to 5 mm. at mid-height within the camerae.

The species *Tripteroceras planodorsatum* (Whitfield), *Tripteroceras shamattawaense* Foerste and Savage, and *Tripteroceras tenerum* (Billings) present similar cross-sections; also the forms

here described as *Allumettoceras brevicameratum*, *A. curtum*, *A. huronense*, *A. josephianum*, *A. planodorsatum-carletonense*, and *rideauense*. Possibly the specimen figured by Troedsson under *Tripteroceras sp.* (cf. *T. oweni* Clarke) should be included in this group. All are referred here provisionally to *Allumettoceras*, although the forms of the segments of their siphuncles are not known.

47. **Allumettoceras tenerum** (Billings)

Plate 13, figs. 11A, B

Orthoceras tener Billings, Canadian Nat. Geol., *5*, 174 (1860).

Specimen 47 mm. long, its lower half slightly curved lengthwise, the radius of curvature of its convex side here being 100 mm. The lateral diameter of the conch enlarges more rapidly along the lower half of the specimen than farther up. At the base of the specimen this diameter is 8 mm., increasing to 13 mm. at a point 23 mm. farther up; to 14.8 mm. at 34.5 mm. above its base, and to 15.7 mm. at 46 mm. from this base. The corresponding dorso-ventral diameters are 6 mm., 9.5 mm., 11 mm., and again 11 mm. The lower half of the specimen is distinctly flattened along its ventral side for at least two-thirds of the lateral diameter of the conch. The siphuncle is small and evidently either in contact with the ventral wall of the conch, or almost in contact with the latter. The segments of the siphuncle enlarge within the camerae. Where the lateral diameter of the conch is 10 mm., the maximum diameter of these segments is 1.1 mm., contracting to about 0.6 mm. at the septal necks. A central cylindrical silicified column, 0.6 mm. in diameter, extends through several of the segments in a vertical direction, suggesting the presence of a central tubular endosiphuncle, the part immediately exterior to this endosiphuncle formerly having been occupied by calcareous deposits within the interior of the siphuncle. However, nothing definite is known of such a form of deposit. Where the lateral diameter of the conch is 12 mm., 8 segments of the siphuncle occur in a corresponding length immediately beneath; the same number of segments occurs where this diameter is 10 mm. The siphuncle is exposed for a length of 20 mm., but it can not be determined

where the top of the phragmacone is located, even approximately. At the base of the specimen the septum rises slightly in a dorsad direction. It is only faintly curved dorsoventrally, but is strongly concave from right to left. Along the dorsal side of the conch the downward curvature of the suture of this septum is moderate, but it is more conspicuous between the ventrolateral angles of the conch, as in *Tripteroceras planodorsatum*. Faint lines of growth along the upper half of the specimen suggest that this specimen retains the margin of its aperture. This margin is nearly directly transverse dorsally and along the median part of its ventral side, but slopes downward laterally in a ventrad direction at an angle of about 15 degrees with the horizontal.

Occurrence.—Paquette Rapid, at Allumette Island on the Ottawa River; in the Leray member of the Black River. No. 1287, in the National Museum of Canada.

48. **Allumettoceras** (?) **planodorsatum** (Whitfield)

Plate 22, fig. 4

Cyrtoceras planodorsatum Whitfield, Geol. Wisconsin, *4*, 231, pl. 7, figs. 10–12 (1882).

Tripteroceras planodorsatum Clarke, Geol. Minnesota, *3*, pt. 2, 792, pl. 56, fig. 4 (1897).

The original of Clarke's figure, cited above, is 35 mm. long, and enlarges laterally from a diameter of 11.6 mm. at the base of the living chamber to 13.4 mm. at a point 18 mm. farther up. The ventral side of its cross-section is strongly flattened, its lateral sides are narrowly rounded, and its dorsal side is flattened somewhat by pressure, but originally was broadly convex, as is known from other specimens. The 6 camerae beneath the living chamber occupy a total length of 8.3 mm. The sutures of the septa curve downward almost 1 mm. along the median part of the ventral side of the conch, form low saddles ventrolaterally, and then curve slightly downward on crossing the dorsal side of the conch.

Occurrence.—The specimen here described was found at Minneapolis, Minnesota, in the Platteville member of the Black River. No. 46529, U. S. National Museum.

49. **Allumettoceras planodorsatum carletonense** Sp. nov.

Plate 13, figs. 10A, B

Holotype consisting of a living chamber 45 mm. long, enlarging from a lateral diameter of 17 mm. at its base to 21 mm. at a point 22 mm. farther up, its apical angle in this direction being about 10 degrees. Its dorsoventral diameter increases from 12 mm. at its base to 16 mm. at a point 33 mm. farther up. The ventral side of the conch is so strongly flattened as to be only slightly convex for a width of scarcely three-fourths of the lateral diameter of the conch. Its dorsal side is evenly convex, its transverse curvature equalling a little more than one fourth of the circumference of a circle having a diameter of 18 mm., at the base of the specimen, this diameter increasing to about 28 mm. at its top. The lateral sides of this specimen are relatively broadly rounded. The septum at the base of the living chamber has a concavity of 2 mm. Its suture curves only slightly downward dorsally, but 2.5 mm. ventrally, in a manner very similar to the course of the sutures as figured by Clarke from the Black River at Minneapolis, Minnesota, under the name *Tripteroceras planodorsatum*. The siphuncle is not preserved at the base of the specimen.

Occurrence.—South of Ottawa, in lots 3 and 4, concession III, Gloucester township, Carleton county, Ontario, Canada; in the Black River. No. 6835, in the National Museum of Canada.

Remarks.—This specimen evidently is closely related to *Allumettoceras planodorsatum*, differing chiefly in its larger size, though specimens preserving parts of the phragmacone probably will show other differences as well.

50. **Allumettoceras huronense** Sp. nov.

Plate 13, figs. 7A, B

Specimen 28 mm. long, consisting of a living chamber with a single camera attached, the latter being 1.3 mm. long. The conch enlarges laterally from a diameter of 14 mm. at the base of the living chamber to 18.5 mm. at a point 20 mm. farther up, indicating an apical angle of 15 degrees. The corresponding dorsoventral diameters are 10 mm. and 13.5 mm. The suture of the

septum at the base of the living chamber slopes slightly downward in a ventrad direction. There is no conspicuous downward flexure of this septum as in *Allumettoceras planodorsatum* (Whitfield). The concavity of the septum is 1 mm. The center of the siphuncle is 1 mm. from the ventral wall of the conch, and its diameter is also 1 mm.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype; no. 13405, in the museum of the University of Michigan. A fragment of a similar specimen is numbered 13407.

Remarks.—This specimen differs from the type of *Allumettoceras josephianum* in its smaller apical angle, and in the larger size of its siphuncle. The single camera still attached also is much shorter, though this may be merely a gerontic feature, the uppermost camera of mature specimens often being conspicuously shorter than the camerae beneath.

51. **Allumettoceras rideauense** Sp. nov.

Plate 22, figs. 9A, B

Specimen 23 mm. long, enlarging laterally from a diameter of 8.3 mm. at its base to 11 mm. at a point 17 mm. farther up, the apical angle being 9 degrees. The corresponding dorsoventral diameters are 6.8 mm. and 9 mm., the conch being slightly depressed dorsoventrally, chiefly owing to a slight flattening of the median part of its ventral side. Of the living chamber a length of 18 mm. remains, measured along the median part of its ventral side. At its base 5 camerae still are attached. The uppermost one of these is sufficiently shorter than the remainder to suggest that the conch had reached its gerontic stage. The 4 underlying camerae occupy a total length of 4.3 mm., suggesting the former presence of about 8 or 8.5 camerae in a length equal to the lateral diameter of the conch. Along the dorsal half of the conch the sutures of the septa are directly transverse, but between the ventrolateral angles of the conch they curve downward for a distance of almost 1 mm. The siphuncle is assumed to have been located close to the ventral wall of the conch.

Occurrence.—On the right bank of the Rideau River, south of Ottawa, Ontario, Canada, below the elevation known as Hogs Back; in the Chazyan. Holotype, no. 6836, in the National Museum of Canada.

Remarks.—This species is characterized by its relatively small size, its moderate rate of enlargement, and its relatively small dorsoventral depression, its ventral flattening being small and confined to the median third of the conch, the transverse section of the latter being transversely elliptical, excepting for this median ventral part.

52. **Allumettoceras brevicameratum** Sp. nov.

Plate 13, figs. 9A, B

Specimen 42 mm. long, enlarging laterally from a diameter at the base of the living chamber estimated at 18 mm. to 24.5 mm. at its top, the angle of enlargement in this direction being 12.5 degrees. In a dorsoventral direction the corresponding diameters are 13.4 mm. and 17 mm. The conch is slightly curved lengthwise, its ventral outline being convex. Its cross-section resembles that of *Allumettoceras planodorsatum*, its general form being transversely elliptical, with its longer axis in a lateral direction, but with the median part of its ventral side distinctly flattened. The living chamber is 40 mm. long. The cast of the interior of this chamber is slightly contracted just beneath the aperture for a length of 8 mm., corresponding to the slight annular thickening of the interior of the shell just below the aperture in other orthoceroids, this annular thickening being low but broad. In addition, this cast of the interior of the living chamber is marked by low and very faint vertical ribs, from 4 to 5.5 ribs in a width of 5 mm. The most characteristic part of the specimen is its camerated part. Of this it retains 3 camerae, all very short. Each of the two lower camerae is 1 mm. in length, and the uppermost one is 0.8 mm. long, possibly indicating that the conch had reached maturity. The sutures of the septa curve downward ventrally about 0.7 mm. and rise the same distance dorsally above their level laterally.

The siphuncle appears to be 1.1 mm. in diameter, but is located 2.2 mm. from the flattened ventral side of the conch.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron, Ontario; in the Black River. Holotype no. 14478, in the museum of the University of Michigan. Collected by A. Winchell.

Remarks.—This species is characterized chiefly by its short camerae.

53. **Allumettoceras curtum** Sp. nov.

Plate 22, figs. 8A, B

Specimen 17 mm. long, enlarging from a lateral diameter of 12.8 mm. at its base at an angle of 26 degrees, and from a dorsoventral diameter of 9 mm. at an angle of 12 degrees. The cross-section of the conch is similar to that of *Allumettoceras planodorsatum* rather than to that of *Triptoceras hastatum*. Only the median part of the ventral side is flattened, and there is no dorsolateral flattening so that the cross-section of the conch may be described as elliptical, with its major axis in a lateral direction, and with its ventral outline moderately flattened. The suture of the septum at the base of the specimen appears to curve more strongly downward ventrally than dorsally. The concavity of this septum is estimated at 1 mm., though it is evident that its lower surface is chiefly the work of the cleaner. The center of the siphuncle is 1.1 mm. from the ventral wall of the conch. The only segment exposed is 1.1 mm. in length and increases in diameter from 0.6 mm. at the septal neck to 0.9 mm. at mid-height within the camera. The surface of the specimen appears to have been smooth ventrally and ventrolaterally, but dorsally it has weathered so as to show weak transverse wrinkles.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron, Ontario. Holotype, no. 13406, in the Museum of the University of Michigan.

Remarks.—This species is founded chiefly on its rapid rate of enlargement, compared with other species having essentially the same cross-section.

54. **Allumettoceras josephianum** Sp. nov.

Plate 22, figs. 10A, B

Specimen 31 mm. long, enlarging from a lateral diameter of 14.2 mm. near its base to 20.5 mm. at a point 20 mm. farther up, its apical angle in this direction being 19 degrees. The corresponding dorsoventral diameter near the base of the specimen is 10.5 mm., but that at its top can not be determined since the living chamber was crushed dorsoventrally after the death of the animal. The cross-section of the conch is similar to that of *Allumettoceras planodorsatum* in its transversely elliptical outline, its maximum diameter being in a lateral direction, and its ventral part being only moderately flattened. At the base of the living chamber, where its lateral diameter is 17.3 mm., the immediately underlying 5 camerae occupy a length of 9 mm. ventrally and 7.5 mm. dorsally. The sutures of the septa curve only very slightly downward ventrally, and scarcely more than half a millimeter dorsally. The passage of the siphuncle through the septum at the base of the specimen is 0.6 mm. in diameter, and its center is located 1.6 mm. from the ventral wall of the conch.

Occurrence.—St. Joseph Island, in the northwestern part of Lake Huron; in the Black River. Holotype, no. 2459, in the museum of the University of Michigan.

Remarks.—This specimen is characterized by its relatively large lateral apical angle, though smaller than that of *Allumettoceras curtum* Foerste. Moreover, compared with other species having a somewhat similar rate of enlargement, the camerae are relatively long.

TRIPTEROCERAS Hyatt

Genotype: *Orthoceras hastatum* Billings, Geol. Surv. Canada, Rept. of Progress for 1853–56, 333, (1857). *Tripteroceras hastatum* Hyatt, Proc. Boston Soc. Nat. Hist., *22*, 287, (1884); also Foerste, Jour. Sci. Lab. Denison Univ., *20*, 231, pl. 31, figs. 3A–D (not figs. 2A–D, which illustrate *Allumettoceras paquettense* Foerste) (1924).

Conch strongly depressed dorsoventrally, strongly flattened

ventrally, and sufficiently flattened along the two halves of the dorsal side to produce a more or less distinct angularity along its median part. Lateral angles of the cross-section narrowly rounded or obscurely truncated. Siphuncle relatively small and located near the ventral side of the conch, but not in contact with the latter. The genus includes *Tripteroceras hastatum* (Billings) and *Tripteroceras planoconvexum* (Hall). *Tripteroceras oweni* Clarke apparently also belongs here.

Tripteroceras xiphias (Billings) has a larger siphuncle than that supposed to be characteristic of the genus, but appears to resemble the latter in its general form. *Tripteroceras scofieldi* Foerste probably had about the same cross-section as *Tripteroceras xiphias*, but nothing is known of its siphuncle.

55. **Tripteroceras hastatum** (Billings)

Plate 13, fig. 8

Orthoceras hastatum Billings, Geol. Surv. Canada, Rep. of Progress for 1853–56, 333 (1857).

Tripteroceras hastatum Foerste, Jour. Sci. Lab. Denison Univ., *20*, 232, pl. 31, figs. 3A–D (1924); not figs. 2A–D, which represent *Tripteroceras pauquettense*, the names of these two species being interchanged in the description of the plate, but correctly given in the text.

Fragment 16 mm. long along the median part of its dorsal side, and with a lateral diameter of 18.1 mm. at its base, the corresponding dorsoventral diameter being estimated at 9.5 mm. The center of the siphuncle is about 1 mm. from the flattened ventral wall of the conch. The passage of this siphuncle through the septum at its base is 0.6 mm. in diameter and its segments enlarge to 0.9 mm. at midlength within the camerae. Judging from these segments, the camerae here are 1.75 mm. in length. The septum slopes slightly downward in a ventrad direction, and is very faintly curved dorsoventrally in a lateral direction, however, its radius of curvature is about 11 or 12 mm., the sutures of the septa curving strongly downward both dorsally and ventrally.

Occurrence.—Paquette Rapid, at Allumette Island in the Ottawa

River; in the Leray member of the Black River. No. 6837, in the National Museum of Canada.

Remarks.—This specimen is of interest on account of its giving some information regarding the structure of the siphuncle of the genotype of *Tripteroceras*.

56. **Tripteroceras planoconvexum** (Hall)

Plate 22, figs. 1A, B, C; 3A, B; plate 23, fig. 6

Orthoceras planoconvexum Hall, Rept. Superintendent of Geol. Surv. Wisconsin, 47 (1861); Whitfield, Geol. Wisconsin, *4*, 228, pl. 7, fig. 14, (1882); Mem. Amer. Mus. Nat. Hist., *1*, pt. 2, 72, pl. 8, figs. 24, 25; pl. 9, figs. 1, 2, (1895).

Fragment 35 mm. long, enlarging laterally at an apical angle of 15 degrees and dorsoventrally at an angle of 12 degrees. At the base of the specimen its lateral diameter is 20 mm. and its dorsoventral one is 10 mm. The convexity of the ventral side here is slightly more than 1 mm. The lateral sides are nearly 4 mm. in width and converge in a dorsad direction at an angle of about 15 degrees. The dorsolateral sides are distinctly flattened, converging at an angle of 120 degrees. All the angles are rounded, the ventrolateral ones being most angular, the median ventral one being least. At the base of the specimen 4 camerae occupy a length of 10 mm., the beginning of a fifth camera being indicated in the immediately overlying part, 2.5 mm. long. It is estimated that about 11 camerae occurred in a length equal to the lateral diameter of the conch along the upper part of the phragmacone. At the base of the specimen the concavity of the septum equals 1.5 camerae in a lateral direction, this being the amount of the downward curvature of its suture on the ventral side of the conch. On its dorsal side the suture also curves downward, but less strongly, the amount being 1.3 mm. less. On approaching the lateral outline of the conch the sutures curve faintly outward. There is a faint upward curvature of the sutures along the median part of the dorsal side of the conch. The siphuncle is not indicated distinctly. It appears to have been small, its center being 1.4 mm. from the ventral wall of the conch. The specimen

includes the lower part of a living chamber and the top of the phragmacone. At the top of uppermost well defined camera its lateral diameter is 23.7 mm. Plate 22, fig. 1B.

The accompanying living chamber mentioned by Hall in his description of the species is 65 mm. long, and appears to be preserved for its entire length, from the septum at its base to the aperture at its top. At this top its lateral diameter is estimated at 31.5 mm., and its dorsoventral diameter at approximately 16.5 mm. The apical angle along the upper 45 mm. of the length of this chamber is about 11 degrees, which is smaller than in the preceding specimen; however, below the point at which its lateral diameter is 23 mm., the apical angle appears to have been greater. In other respects this specimen closely resembles the preceding, especially in its cross-section and in the course of the single septum at its base. The specimen consists of a cast of the interior of the living chamber, but its ventral side retains distinct lines of growth of the shell. Where the lateral diameter of the conch is 26 mm. these lines rise slightly along the median part of this ventral side and also toward the lateral margins of the conch, leaving very shallow lobes whose maximum depth is 5 mm. from these margins. Along the narrow lateral sides of the conch these lines of growth rise in a dorsad direction. One of the dorsolateral sides of the conch has weathered apparently so as to appear transversely banded, the bands curving slightly downward along the middle of their course, but it is not certain that these bands indicate corresponding markings on the surface of the shell. Plate 22, fig. 1A.

A third specimen, belonging to the type series studied by Hall, but not mentioned by him in his description, consists of the top of a living chamber, preserved for a length of about 20 mm. At the aperture this specimen has a lateral diameter of 31 mm. and a dorsoventral one of 16.5 mm. The cross-section conforms with that of the preceding specimens, but the living chamber flares faintly at the aperture. Plate 22, fig. 1C.

Occurrence.—Beloit, Wisconsin; in the Platteville member of the Black River formation. Cotypes, no. 981, American Museum of Natural History.

Remarks.—This evidently is a typical member of the genus *Tripteroceras*, with a small siphuncle, located close to the ventral wall of the conch.

Another specimen, from the same locality as the cotypes, occurs in the museum of the University of Michigian.

Specimen 55 mm. long, faintly curved lengthwise, with its ventral side convex and its dorsal one concave. Enlarging from a lateral diameter of 17 mm. at its base to 30 mm. at its top, its apical angle being 16 degrees. The corresponding dorsoventral diameters are 9 mm. and 16.5 mm. The lateral sides of the conch tend to be flattened, the flattened areas distinctly converging in a dorsad direction, at an angle of about 80 degrees with the transverse axis of the cross-section of the conch. At the top of the specimen this flattened area is approximately 5 mm. wide. The dorsal side appears to retain faint traces of transverse lines arching upward slightly along the median part of this side, which tends to be faintly angular here owing to a slight flattening of the dorsolateral parts of the conch on each side of this median line. There is no trace of a septum at the base of the specimen.

Occurrence.—Beloit, Wisconsin; in the Platteville member of the Black River. No. 2880, in the museum of the University of Michigan. Plate 22, figs. 3A, B.

57. **Tripteroceras** cf. **planoconvexum** (Hall)

Plate 22, figs. 2A, B

Specimens attaining a maximum lateral diameter of 35 mm., and estimated to have reached a total length of 155 mm. Two of the specimens appear to be living chambers with a lateral diameter of 18 mm. at their base, indicating that their phragmacones were about 60 mm. long, if their apical angles of 7 degrees extended unchanged as far as the apical end of the conch. In that one of these two specimens which preserves the entire length of the living chamber, this length is 52 mm. Near the aperture the walls of this chamber flare outward slightly. Judging by a line of growth the ventral margin of the aperture arched slightly upward. Where the lateral diameter is 37.5 mm., the corresponding dorso-

ventral one is 14.5 mm. The ventral side of the cross-section of the conch is only slightly convex and rounds rather abruptly into its narrow lateral sides. The latter have a width of about 4 mm., and form an angle of about 85 degrees with the ventral sides. The dorsal side of the cross-section is almost evenly convex in some specimens and shows a slight tendency toward angularity along its median line in others.

Occurrence.—Southeast of Ottawa, Ontario, Canada, in lots 3 and 4, of concession III, R. F., in Gloucester township, Carleton County; in the Black River. No. 6838, in the National Museum of Canada.

Remarks.—In size and form these specimens resemble the type of *Tripteroceras planoconvexum*, from the Platteville of Wisconsin, very much, and may be identical.

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PLATE VII

Fig. 1. *Richardsonoceras falx* (Billings). A, dorsal view; B, lateral view, with ventral margin on left; C, lateral view, with upper part of conch ground down to expose the siphuncle near its ventral margin. Paquette Rapid, Allumette Island, southwestern margin of province of Quebec; in the Leray member of the Black River formation. Three specimens from the series of cotypes, no. 1298, National Museum of Canada. See also Plate 26, fig. 6.

Fig. 2. *Kentlandoceras schrocki* Foerste. A, lateral view with convex ventral margin on left; B, ventral view showing glimpses of the siphuncle. Kentland, Newton county, northwestern Indiana; in the Platteville member of the Black River formation. No. 87116, U. S. National Museum.

Fig. 3. *Endoceras* (?) *rapax* (Billings). Lateral view of part of a phragmacone, showing the sutures of the septa. Kingston, Ontario, Canada; from the Black River formation. Topotype, no. 1355, National Museum of Canada.

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PLATE VIII

Figs. 1, 2, 3. *Cameroceras* (?) *multicameratum* (Emmons). 1, ventral view, omitting upper end of specimen; 2, lateral view, with ventral outline on right, omitting part of top and bottom of specimen; 3, lateral view of entire length of specimen. Figs. 1 and 2 are reduced to four-fifths of natural size; fig. 3 is three-fifths of natural size. Watertown, New York; in the Black River formation. No. 581, Amer. Mus. Nat. Hist. Original of Hall's fig. 1, on plate 11 of Pal. New York, *1* (1847). See also plate 9, fig. 1.

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PLATE IX

Fig. 1. *Cameroceras* (?) *multicameratum* (Emmons). Ventral side, weathered so as to expose the siphuncle. Watertown, New York; in the Lowville member of the Black River formation. No. 12385, in the New York State Museum. Original of Hall's fig. 1c, on pl. 11, of Pal. New York, *1* (1847). See also pl. 8.

Fig. 2. *Sactoceras josephianum* Foerste. A, lateral view with convex outline on left; B, another specimen, weathered so as to expose the siphuncle. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Nos. 14472, and 14473 respectively, Museum of Univ. of Michigan.

Fig. 3. *Sactoceras josephianum* Foerste. A, lateral view with convex outline on right; B, another specimen cut to expose the siphuncle. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Nos. 14475 and 14476 respectively, Museum of Univ. of Michigan.

Fig. 4. *Sactoceras* (?) *ottawaense* (Billings). Lateral view. Ottawa, Ontario, Canada; in the Black River formation. No. 1719b, in the National Museum of Canada.

Fig. 5. *Sactoceras pictolineatum* Foerste. A, exterior of conch, showing sutures of septa; B, same side, enlarged so as to show the vertical dark brown lines; opposite side, ground down, to show several segments of the siphuncle. From the drift at Ann Arbor, Michigan; probably from the Black River formation at some unknown locality in northern Michigan or northwestern Lake Huron. No. 13357, in the Museum of the Univ. of Michigan.

Fig. 6. *Whitfieldoceras exiguum* (Billings). A, lateral view; B, ventral view. Near L'Original, 52 miles east of Ottawa, Ontario, Canada; in the Trenton formation. Copied from Billings, Canadian Nat. Geol., *5*, 172, figs. 17, 18 (1860).

Fig. 7. *Cyrtorizoceras minneapolis* (Clarke). Outline of aperture of living chamber. Minneapolis, Minnesota; in the Platteville member of the Black River. No. 46525, U. S. National Museum. See also plate 29, figs. 7 A, B. Geol. Minnesota, *3*, pt. 2, pl. 59, figs. 7, 8 (1897).

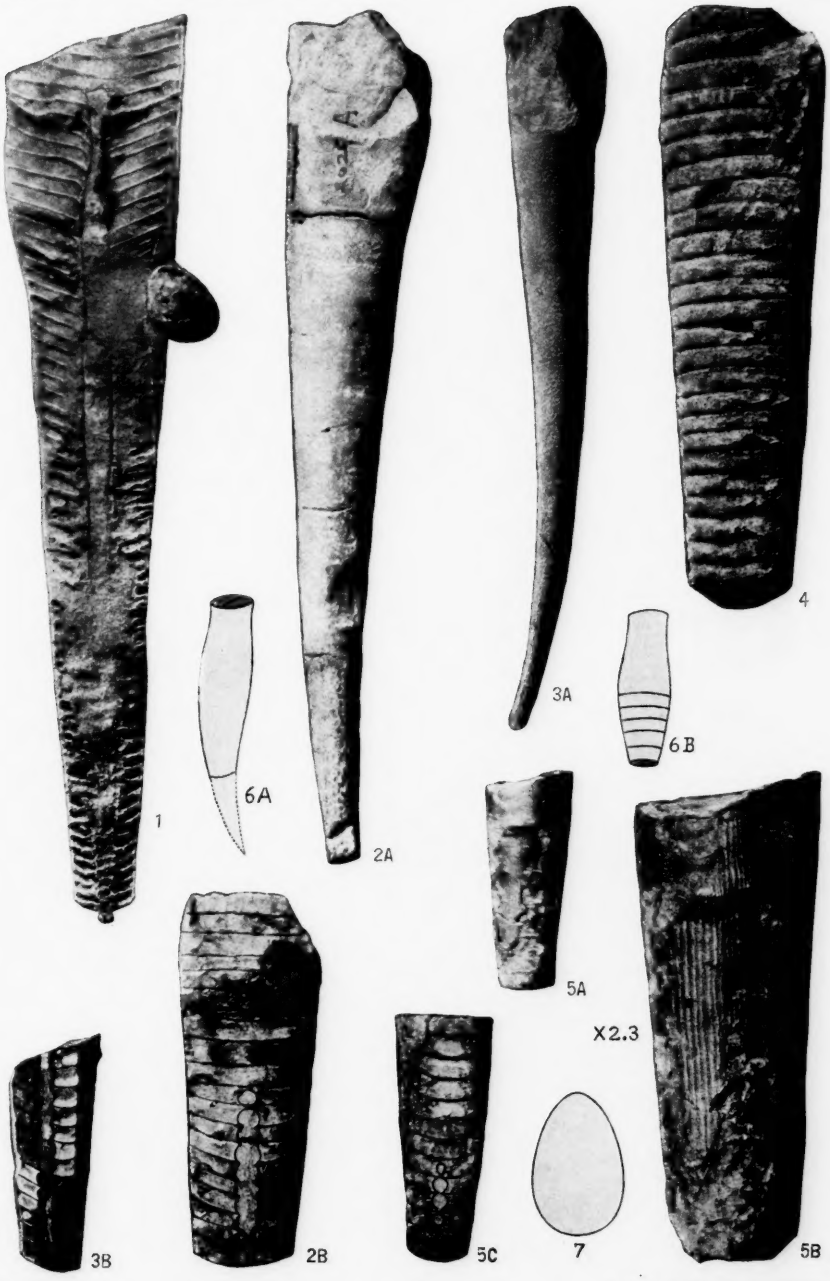

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PLATE X

Fig. 1. *Geisonoceras scofieldi* Foerste. A, living chamber, contracted at top, occurring in an endocone of some species of *Endoceras;* B, same living chamber, showing very narrow, brown, vertical color lines. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 204, Museum of Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 55, figs. 4, 5, 6 (1897).

Fig. 2. *Orthoceras josephianum* Foerste. A, lateral view, enlarged, to show the vertical, brown color lines; B, same, natural size. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 14417, Museum of Univ. of Michigan.

Fig. 3. *Orthoceras huronense* Billings. A, dorsal side, showing sutures of septa; B, ventral side, retaining dark brown, vertical color bands on the living chamber. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Holotype; no. 1724, in the National Museum of Canada.

Fig. 4. *Orthoceras ontarioense* Foerste. A, larger fragment with septum at base; B, smaller fragment, with septum at top and base; length of camerae uncertain. Paquette Rapids, Allumette Island, Ottawa river, between Ontario and Quebec, Canada. No. 6826, National Museum of Canada.

Fig. 5. *Sactoceras tyronense* Foerste. Lateral view, with convex ventral outline on left. Surface of shell smooth, covered with *Dermatostroma tyronensis* Foerste. High Bridge, Kentucky; in the Tyrone member of the Black River formation. Holotype; Jour. Sci. Labs. Denison Univ. *17*, pl. 10, fig. 5A. (1912). No. 87109, U. S. National Museum.

Fig. 6. *Orthoceras romingeri* Foerste. A, lateral view, with ventral outline on left; B, ventral view, showing sutures of septa; both views show broad, dark brown, vertical color bands. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Holotype, no. 14420, Museum of Univ. of Michigan.

Fig. 7. *Orthoceras romingeri* Foerste. Fragment assumed to belong to this species, cut to show the siphuncle. St. Joseph Island, in the Black River formation. 14421, Museum of Univ. of Michigan.

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PLATE XI

Fig. 1. *Metaspyroceras* (?) *nicolleti* (Clarke). Lateral view, the lower part belonging to the phragmacone. Belle Creek, Minnesota. In the Platteville member of the Black River formation. No. 4124, in the Scofield Coll. Museum of the Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 55, figs. 1, 2 (1897).

Fig. 2. *Spyroceras arcuoliratum* (Hall). Lateral view, with ventral outline on left. Middleville, New York; in the Trenton formation. Lectotype, no. 807, American Museum of Natural History. Pal. New York, *1*, pl. 42, fig. 7a (1847).

Fig. 3. *Spyroceras cylindratum* Foerste. A, lateral view, with ventral outline on right; B, ventral side. Watertown, New York; in the coarse-grained part of the Trenton. Second specimen numbered 807, in the American Museum of Natural History. Pal. New York, *1*, pl. 42, figs. 7b, c (1847).

Fig. 4. *Spyroceras iowense* Foerste. Lateral view. McGregor, Iowa; silicified, possibly from the Decorah member of the Black River formation. No. 8290, in the museum of the Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 47, figs. 22, 23 (1897).

Fig. 5. *Spyroceras teretiforme* (Hall). A, dorsal view; B, lateral view, with ventral outline on right. Watertown, New York; in the dark gray, granular part of the Trenton formation. Holotype, no. 12412, New York State Museum. Pal. New York, *1*, pl. 42, fig. 8a, lower half of figure (1847).

Fig. 6. *Spyroceras cylindratum* Foerste. A, lateral view, with ventral outline on left; B, ventral view. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 6829, National Museum of Canada.

Fig. 7. *Spyroceras cylindratum* Foerste. A, dorsal view; B, lateral view, with ventral outline on right; C, ventral view. Paquette Rapid, Canada. No. 6829, National Museum of Canada.

Fig. 8. *Spyroceras allumettense* Foerste. A, dorsal side; B, lateral view, with dorsal side on right. Paquette Rapid, Canada. No. 6830, National Museum of Canada.

Fig. 9. *Spyroceras allumettense* Foerste. Lateral view, with dorsal side on left. Paquette Rapid, Canada. No. 6830, National Museum of Canada.

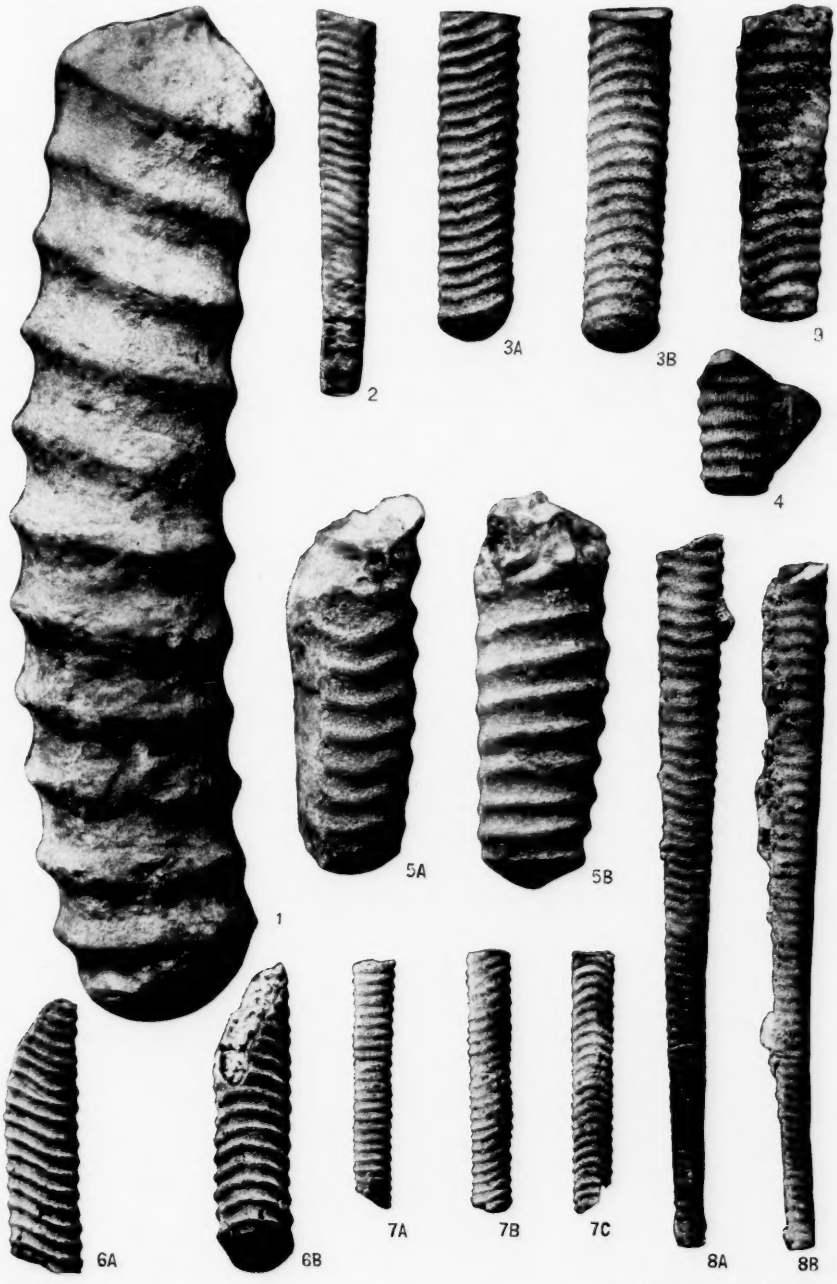

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PLATE XII

Fig. 1. *Cycloceras decrescens* (Billings). A, lateral view of upper part of one specimen. B, C, two halves of upper part of another specimen, one-half showing the siphuncle. La Petite Chaudiere, above Ottawa city, on the Ottawa river, Canada; in the Black River formation. Nos. 1277c, 1277, and 1277a, in the order here figured; in the National Museum of Canada.

Fig. 2. *Cycloceras* (?) sp. (Janesville). Supposed ventral side. Janesville, Wisconsin; in the Platteville member of the Black River formation. In the museum of the Univ. of Minnesota.

Fig. 3. *Cycloceras* sp. (Janesville). Supposed ventral side. Janesville, Wisconsin; in the Platteville member of the Black River formation. No. 8291A, in the museum of the Univ. of Minnesota.

Fig. 4. *Cycloceras* sp. (Minnesota). Supposed dorsal side. Minneapolis, Minnesota; in the Platteville member of the Black River formation. No. 8291, in the Museum of the Univ. of Minnesota. Geol. Minneasota, *3*, pt. 2, pl. 55, fig. 3 (1897).

Fig. 5. *Cycloceras cf. decrescens* (Billings). A, supposed ventral side; B, vertical section through the siphuncle of another specimen. St. Joseph Island; in the Black River formation. Specimens numbered 14455 and 14454 respectively, in the museum of the University of Michigan.

Fig. 6. *Cycloceras romingeri* Foerste. A, ventral side; B, lateral view of crushed specimen with ventral outline on left. St. Joseph Island; in the Black River formation. No. 2831, in the museum of the Univ. of Michigan.

Fig. 7. *Cycloceras cf. decrescens* (Billings). Lateral view. St. Joseph Island; in the Black River formation. No. 14419, in the museum of the Univ. of Michigan.

Fig. 8. *Spyroceras lesueuri* (Clarke). Lateral view, with faintly convex outline on left, and with sutures of septa in lower 12 transverse grooves. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4119, in the Scofield Coll. Museum of the Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 55, fig. 9 (1897).

Fig. 9. *Spyroceras cf. lesueuri* (Clarke). Supposed ventral view. Dixon, Illinois; in the Platteville member of the Black River formation. No. 46528, in the U. S. National Museum. Geol. Minnesota, *3*, pt. 2, pl. 55, fig. 8 (1897).

Fig. 10. *Spyroceras paquettense* Foerste. Lateral view. Paquette Rapid, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 6831, in the National Museum of Canada.

Fig. 11. *Sactoceras ehlersi* Foerste. Vertical section through the siphuncle. St. Joseph Island, Lake Huron, Canada; in the Black River formation. No. 2020, in the museum of the Univ. of Michigan.

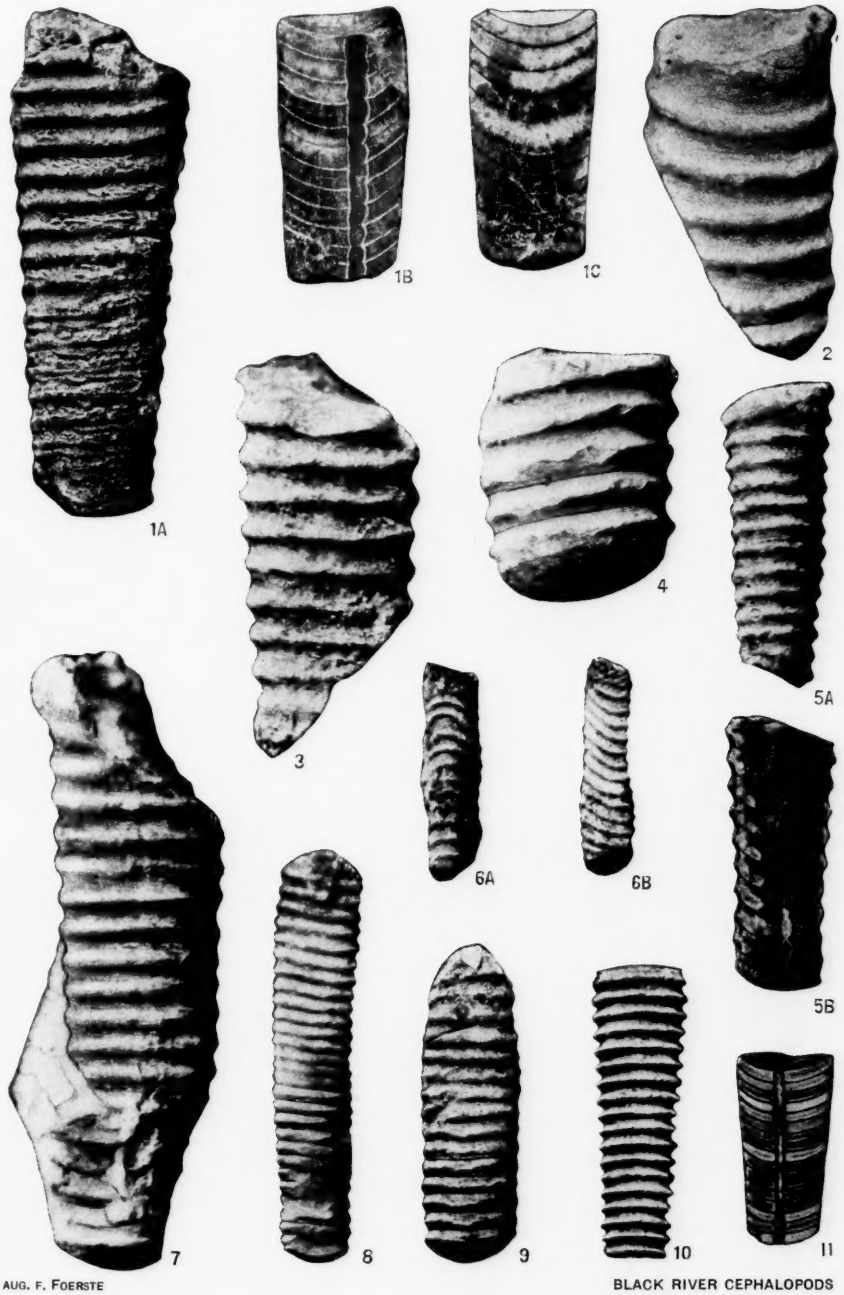

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PLATE XIII

Fig. 1. *Spyroceras beauportense* (Whiteaves). A, holotype, lateral view; B, same, enlarged. Beauport, 3 miles northeast of Quebec City, Canada; in the Trenton formation. No. 4413, National Museum of Canada.

Fig. 2. *Spyroceras whitcombi* Foerste. A, lateral view; same, enlarged; C, another specimen. Bellefonte, Pennsylvania; in the Salona formation, beneath the typical Trenton. Collected by Lawrence Whitcomb.

Fig. 3. *Metaspyroceras clarkei* Foerste. A, ventral view; B, dorsal view. Minneapolis, Minnesota, in the Decorah member of the Black River formation. Holotype, no. 5042, museum of Univ. of Minnesota. Original of Geol. Minnesota, *3*, pt. 2, pl. 47, fig. 20 (1897).

Fig. 4. *Metaspyroceras cf. clarkei* Foerste. Lateral view showing annulations at a much earlier stage than in the preceding specimen. Ford plant, St. Paul, Minnesota; Decorah formation. No. 4131, Univ. of Minnesota.

Fig. 5. *Metaspyroceras clarkei* Foerste. Lateral view, apparently corresponding to earlier part of conch of typical *Spyroceras clarkei*. Ford plant, St. Paul, Minnesota; Decorah formation. No. 4129, Univ. of Minnesota.

Fig. 6. *Metaspyroceras cf. clarkei* Foerste. Lateral view. Minneapolis, Minnesota; Decorah member of the Black River. No. 8284, Univ. of Minnesota. Original of Geol. Minnesota, *3*, pt. 2, pl. 47, fig. 21 (1897).

Fig. 7. *Allumettoceras huronense* Foerste. A, ventral view; B, lateral view with ventral outline on left. St. Joseph Island; in the Black River formation. Holotype, no. 13405, Univ. of Michigan.

Fig. 8. *Tripteroceras hastatum* (Billings). Upper part of phragmacone, viewed from above, showing transverse outline, and location of minute siphuncle close to ventral wall of conch. Paquette Rapid, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 6837, National Museum of Canada.

Fig. 9. *Allumettoceras brevicameratum* Foerste. A, ventral view; B, lateral view, with ventral outline on right. St. Joseph Island; in the Black River formation. No. 14478, Univ. of Michigan.

Fig. 10. *Allumettoceras planodorsatum carletonense* Foerste. A, dorsal view; B, lateral view with dorsal outline on left. Gloucester township, Carleton county, Ontario, Canada; in lot 3, concession 4, R.F.; in the Black River formation. No. 6835, National Museum of Canada.

Fig. 11. *Allumettoceras tenerum* (Billings). A, ventral view, with trace of siphuncle; B, lateral view with ventral outline on right. Paquette Rapid, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. Holotype, no. 1287, National Museum of Canada.

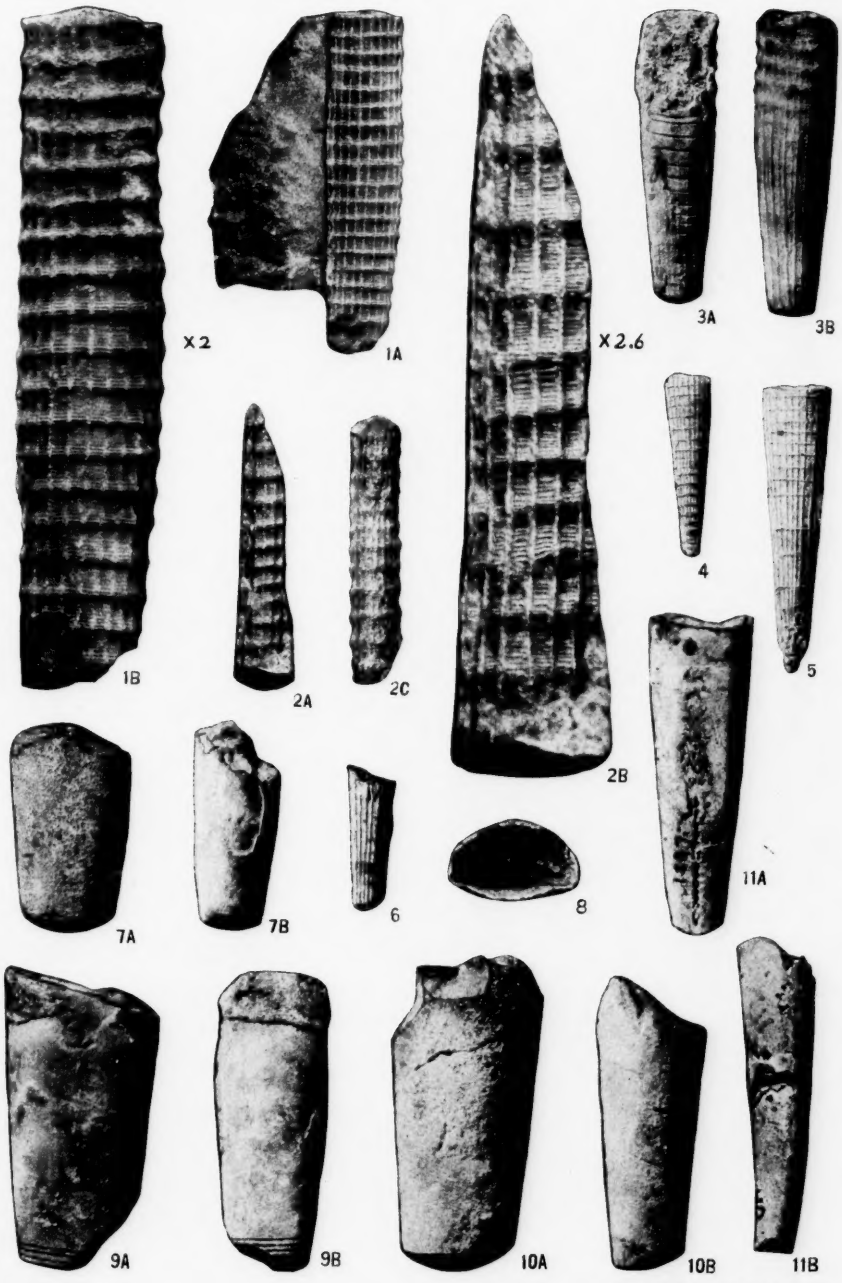

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PLATE XIV

Fig. 1. *Ormoceras hitzi* Foerste. Vertical section through the siphuncle. Madison, Indiana; in the Hitz layer of the Saluda division of the Whitewater member of the Richmond. Holotype; no. 87114, U. S. National Museum. Original of Jour. Sci. Labs. Denison Univ., *16*, pl. 2, fig. 22 (1910), enlarged 1.5 diameters.

Fig. 2. *Polygrammoceras prestonense* Foerste. Lateral view. Preston, Minnesota; in the Trenton formation. No. 8255, Univ. of Minnesota. Geol. Minnesota, 3, pt. 2, pl. 47, fig. 19 (1897).

Fig. 3. *Armenoceras milleri* (Foerste). Lateral view. Two miles south of Crow distillery, 7 miles south of Frankfort, Kentucky; in the Perryville member of the Trenton. Holotype; no. 87113, U. S. National Museum. Jour. Sci. Labs. Denison Univ., *16*, pl. 1, fig. 5 (1910).

Fig. 4. *Armenoceras ehlersi* Foerste. A, dorsal side of conch, weathered, and showing the septa; B, ventral side, ground down to show the siphuncle. St. Joseph Island; in the Black River formation. Nos. 2040, 14456, in the museum of the Univ. of Michigan.

Fig. 5. *Spyroceras mcfarlani* Foerste. Dorsal view, with annulations curving downward medially. Two miles south of Crow distillery, 7 miles south of Frankfort, Kentucky. No. 87115, U. S. National Museum.

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PLATE XV

Fig. 1. *Deiroceras pertinax* (Billings). A, ventral side, weathered so as to expose the septa; B, lateral view, with ventral side on right, weathered so as to show vertical ribbing, possibly associated with vertical color marking on the original surface of the shell; C, cross-section at lower end of specimen, showing location of siphuncle where passing through the septum. Paquette Rapid, Ottawa River, Quebec, Canada; in the Leray member of the Black River formation. Holotype, no. 1276, National Museum of Canada.

Fig. 2. *Deiroceras paquettense* Foerste. A, obliquely lateral view showing siphuncle almost in contact with the ventral wall of the conch, along the lower 3 segments of the siphuncle, where nearer side of the ventrolateral wall of the conch is weathered away; B, dorsal side, showing siphuncle on ventral side of conch; C, cross-section, near upper end of specimen, apparently with siphuncle more distant from ventral wall of conch than at lower end of specimen. Paquette Rapid, Ottawa River, Quebec, Canada; in the Leray member of the Black River formation. Holotype, no. 6840, National Museum of Canada.

Fig. 3. *Deiroceras kindlei* Foerste. A, lateral view, with ventral outline on left; B, two upper camerae of same specimen, with ventral outline on right, ground down so as to expose two segments of the siphuncle. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 14418, museum of Univ. of Michigan.

Fig. 4. *Deiroceras python* Billings. A, dorsal side of siphuncle; B, lateral view, with dorsal side on right; C, ventral view, showing adhesion of septa to base of segments of siphuncle. Ottawa, Ontario; in the Trenton formation. Topotype, no. 1727, National Museum of Canada.

Fig. 5. *Spyroceras perroti* (Clarke). Lateral view. Granger, Minnesota; in the Maquoketa member of the Richmond. No. 4128, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 54, figs. 4, 5 (1897).

1A

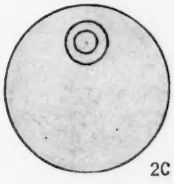
2A

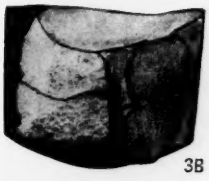
2B

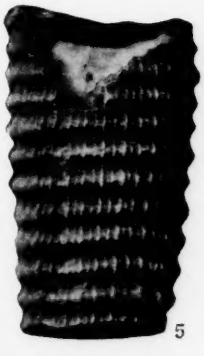
3A

1B

1C


2C


3B


5

4A

4B

4C

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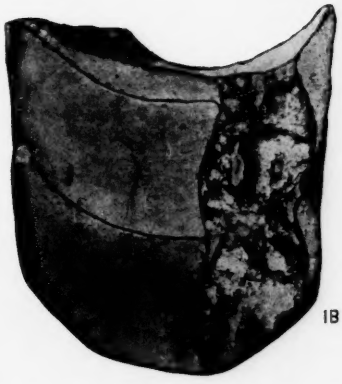
PLATE XVI

Fig. 1. *Deiroceras scofieldi* Foerste. A, lower 6 camerae of a specimen including 12 camerae altogether, with ventral outline on right; B, lower 2 camerae of same specimen, with ventral outline on right, sectioned so as to show the siphuncle. Cannon Falls, Minnesota, in the Platteville member of the Black River formation. No. 4132, museum of Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 54, figs. 1–3, 1897.

Fig. 2. *Deiroceras remotiseptum* (Hall). Weathered in a direction oblique to the dorsoventral plane of symmetry, siphuncle estimated to have been only 1 or 2 mm. distant from the ventral wall of the conch. Watertown, New York; in the Trenton formation. No. 12241, New York State Museum. 3rd Ann. Rept. New York State Cab. Nat. Hist., pl. 4, fig. 3 (1850).

Fig. 3. *Spyroceras* (?) *romingeri* Foerste. A, ventrolateral view; B, lateral view, with ventral outline on right. St. Joseph Island; in the Black River formation. No. 14427, museum of Univ. of Michigan.

1A



1B

2

3A

3B

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PLATE XVII

Fig. 1. *Ormoceras allumettense* (Billings). A, ventral view, weathered so as to expose the siphuncle; B, corresponding view of second specimen; C, cross-section of third specimen, showing location of siphuncle; D, dorsal side of fourth specimen. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. Cotypes, nos. 1265, 1265a, 1265b, and 1265c, National Museum of Canada.

Fig. 2. *Ormoceras josephianum* Foerste. A, dorsal view; B, ventral side ground down to show the siphuncle. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Holotype, no. 14414 Univ. of Michigan.

Fig. 3. *Ormoceras menelaus* (Billings). Supposed dorsal side of conch. Tyendenaga township, Hastings county, Ontario, Canada; in either lot 5 or 6 of concession 9; in the Black River formation. No. 1288, National Museum of Canada.

Fig. 4. *Ormoceras casei* Foerste. A, lateral view, with ventral side on right, sectioned at base so as to show the siphuncle; B, dorsal view. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. Holotype; no. 14463, Univ. of Michigan.

Fig. 5. *Ormoceras paquettense* Foerste. Lateral view, with ventral outline on right weathered. No. 6839, National Museum of Canada.

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PLATE XVIII

Fig. 1. *Actinoceras turinense* Foerste. A, ventral view, exposing part of the siphuncle; B, lateral view, with ventral outline on left. Half a mile east of Turin, Marquette county, Michigan; in the Platteville member of the Black River formation. No. 13366, Univ. of Michigan.

Fig. 2. *Actinoceras billingsi* Foerste. A, lateral view, with ventral outline on right, exposing chiefly the siphuncle; B, ventral outline, showing the lenticular areas of contact of this siphuncle with the ventral wall of the conch. Paquette Rapid, Allumette Island, Ottawa River, Quebec, Canada; in the Leray member of the Black River formation. Holotype, no. 1267b, National Museum of Canada. Original of *Orthoceras bigsbyi* Billings, Geology of Canada, Geol. Surv. Canada, 149, figs. 109a, b (1863).

Fig. 3. *Actinoceras janesvillense* Foerste. A, lateral view, with ventral outline on left, exposing the siphuncle; B, ventral view, also showing the siphuncle. Janesville, Wisconsin; in the Platteville member of the Black River formation. Original of *Actinoceras beloitense* Clarke, Geol. Minnesota, *3*, pt. 2, pl. 47, fig. 18 (1897). No. 8279, Univ. of Minnesota.

1A

1B

2A

3A

3B

2B

PLATE XIX

Fig. 1. *Actinoceras cf. libanum* Foerste and Teichert. A, lateral view, with ventral outline on right, part of segment of siphuncle at its base; section through siphuncle, using same half of specimen; C, ventral view, with part of segment of siphuncle at its base. St. Joseph Island, Lake Huron, Canada; in the Black River formation. No. 2821, museum of Univ. of Michigan.

Fig. 2. *Actinoceras sp.* (St. Joseph). Dorsal view. Possibly belonging to the same species as the preceding, and from the same locality and horizon. No. 14453, museum of Univ. of Michigan.

Fig. 3. *Actinoceras sp.* (Minneapolis). A, lateral view with ventral side on left; B, viewed from above, showing margin of siphuncle along upper margin of figure; C, diagrammatic cross-section of top of specimen; D, specimen viewed from beneath, showing interior of connecting ring of siphuncle; E, diagrammatic cross-section of base of specimen. Minneapolis, Minnesota; in the Black River formation. No. 23, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2., pl. 47, figs. 15, 16 (1897).

Fig. 4. *Actinoceras cf. bigsbyi* Bronn. Vertical section in a lateral direction through the siphuncle; upper half weathered, lower half ground down. Near Rochester, Minnesota; in the Black River formation. No. 159, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 47, fig. 17 (1897).

Fig. 5. *Plectoceras robertsoni* (Hall). Cross-section of the lectotype of this species. Rockford, Illinois; in the Platteville member of the Black River. No. 1003–2, Amer. Mus. Nat. Hist. See also Plate 36, fig. 2 A.

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PLATE XX

Fig. 1. *Leurorthoceras husseyi* Foerste. A, ventral side of lower half of specimen; B, dorsoventral section through the siphuncle of the same, with ventral outline on the right. Cornell, Michigan; in the Trenton formation. No. 14415, Univ. of Michigan. Holotype.

1B

1A

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PLATE XXI

Fig. 1. *Murrayoceras murrayi* (Billings). A, ventral view; B, lateral view with ventral outline on right, the sutures of the septa horizontal laterally and dorsally. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 7512, Univ. of Michigan.

Fig. 2. *Murrayoceras murrayi* (Billings). Ventral view. Gloucester township, Carleton county, Ontario, Canada; in the Black River formation; in lot 4 of concession 3 of that area. No. 6833, National Museum of Canada.

Fig. 3. *Murrayoceras murrayi* (Billings). A, ventral view, the lower part sectioned to show the siphuncle; B, the sectioned part; C, lateral view, with its ventral outline on the right. St. Joseph Island, Lake Huron, Canada; in the Black River formation. No. 13404, Univ. of Michigan.

Fig. 4. *Murrayoceras carletonense* Foerste. A, ventral view, lower part cut to show the siphuncle; B, lateral view with sutures of septa sloping downward in a ventrad direction. Gloucester township, Carleton county; Ontario, Canada; in lot 4 of concession 3; in the Black River formation. No. 6834, National Museum of Canada.

1A

1B

2

4A

3A

3C

4B

3B

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PLATE XXII

Fig. 1. *Tripteroceras planoconvexum* (Hall). A, ventral view of a living chamber; B, ventral view of lower part of living chamber and top of phragmacone of another specimen; C, top of living chamber of a third specimen. Beloit, Wisconsin, in the Platteville member of the Black River formation. Cotypes, no. 981, American Museum of Natural History. See also plate 23, fig. 6. Memoir Amer. Mus. Nat. Hist., *1*, pt. 2, pl. 8, figs. 24, 25; pl. 9, figs. 1, 2 (1895).

Fig. 2. *Tripteroceras cf. planoconvexum* (Hall). A, ventral view of living chamber; B, lateral view showing narrow flattened lateral side of conch. Southeast of Ottawa, Canada, in lots 3 and 4 of concession 3, R.F., in Gloucester township, Carleton county; in the Black River formation. No. 6838, National Museum of Canada.

Fig. 3. *Tripteroceras planoconvexum* (Hall). A, dorsal view; B, lateral view, showing the faint flattening of the lateral side of the conch, with ventral outline on right. Beloit, Wisconsin; in the Black River formation. No. 2880, Univ. of Michigan.

Fig. 4. *Allumettoceras planodorsatum* (Whitfield). Ventral view. Minneapolis, Minnesota; in the Platteville member of the Black River formation. No. 46529, U. S. National Museum.

Fig. 5. *Kionoceras allumettense* Foerste. Lateral view. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 6828, National Museum of Canada.

Fig. 6. *Kionoceras huronense* Foerste. A, lateral view showing vertically striated surface; B, opposite side showing the camerae. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 14426, Univ. of Michigan.

Fig. 7. *Kionoceras multistriatum* Foerste. A, ventral side of specimen showing horizontal color bands immediately beneath the septa; B, lateral view, with ventral outline on left, showing restriction of color bands chiefly to ventral side of conch; C, ventral side enlarged, to show the vertical striae. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 2462, Univ. of Michigan.

Fig. 8. *Allumettoceras curtum* Foerste. A, dorsal view; B, lateral view, with ventral outline on left. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 13406, Univ. of Michigan.

Fig. 9. *Allumettoceras rideauense* Foerste. A, ventral view; B, lateral view with ventral outline on left. Right bank of Rideau river, south of Ottawa, Ontario, Canada, below Hog's Back; in the Chazyan. Holotype, no. 6836, National Museum of Canada.

Fig. 10. *Allumettoceras josephianum* Foerste. A, lateral view; B, ventral view. St. Joseph Island, Lake Huron, Canada, in the Black River formation. Holotype, no. 2459, Univ. of Michigan.

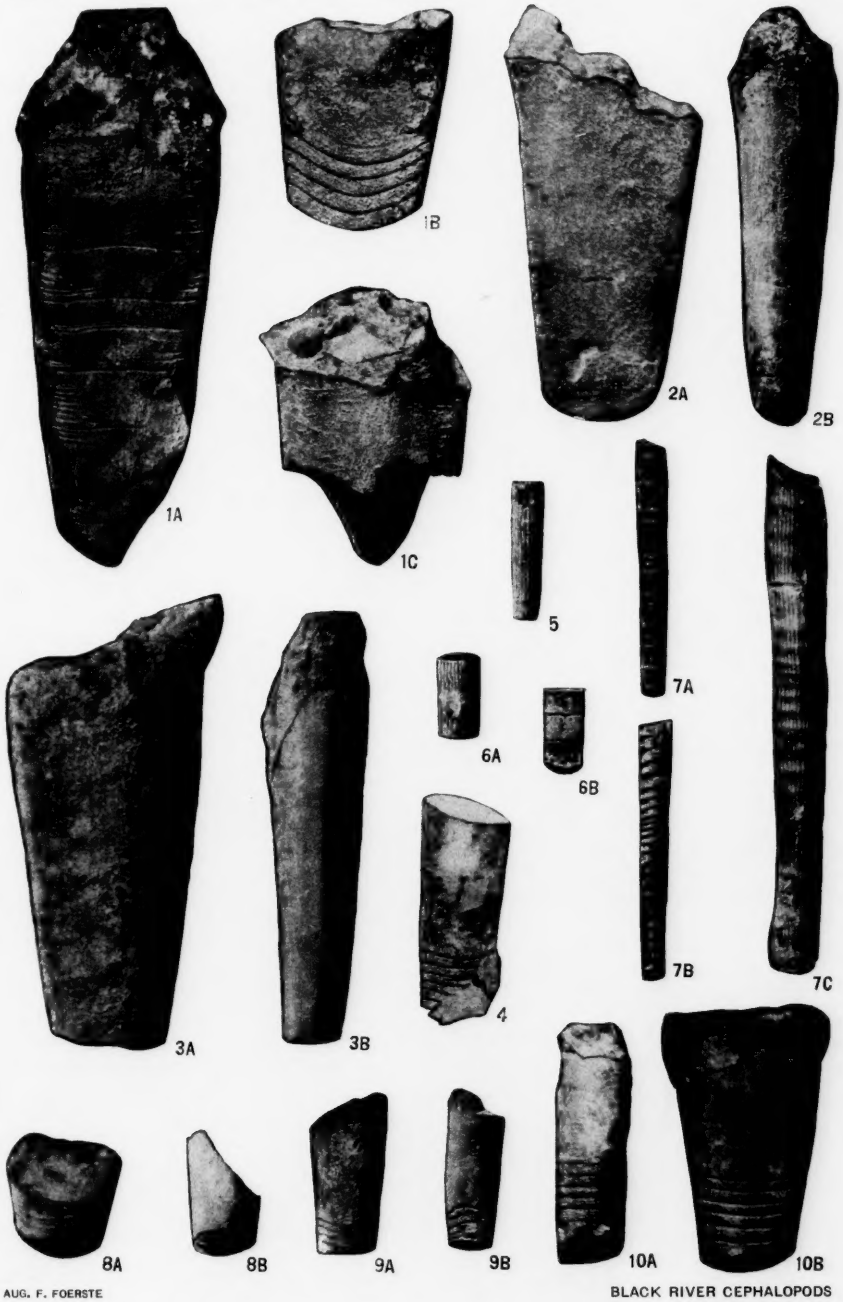

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PLATE XXIII

Fig. 1. *Gonioceras kayi* Foerste. Ventral view. Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 8298, Univ. of Minnesota.

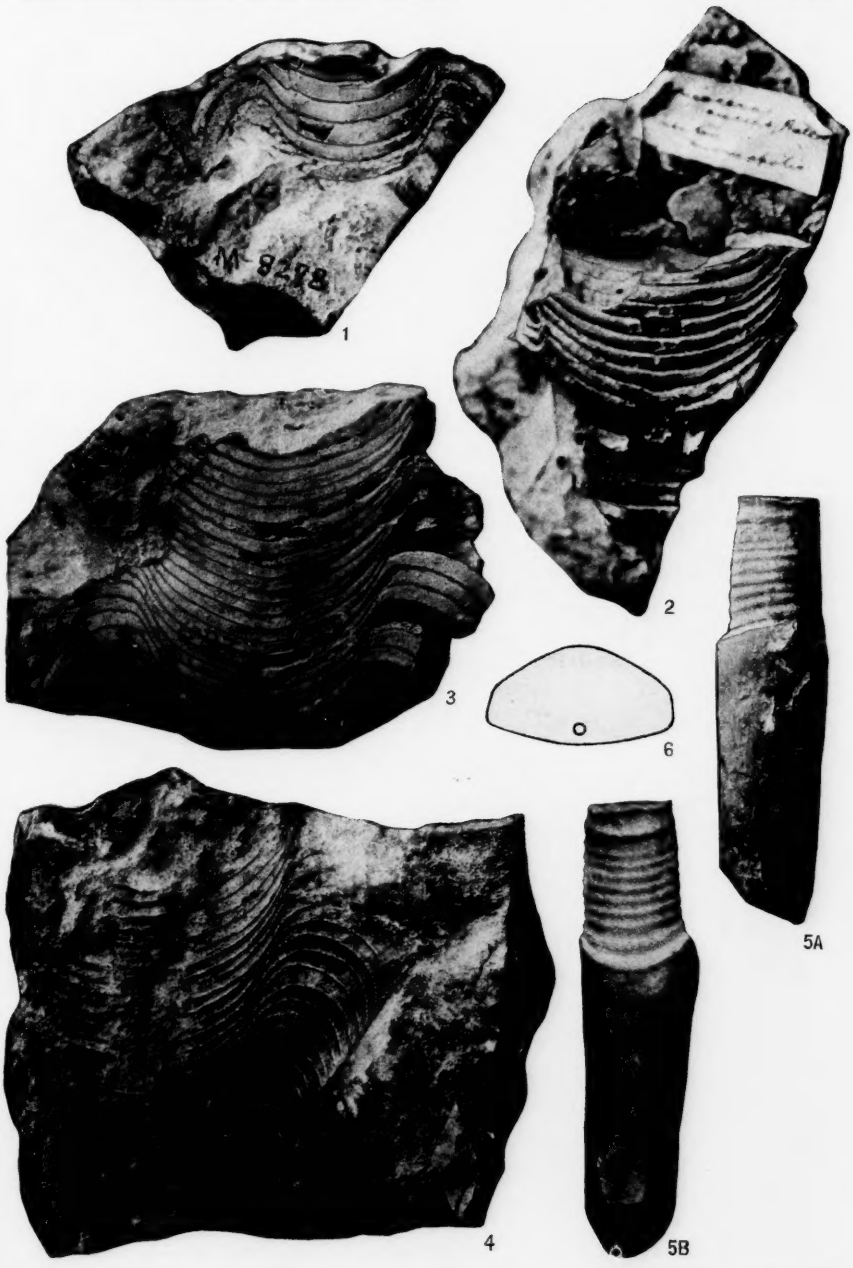
Fig. 2. *Gonioceras occidentale* Hall. Ventral view. Minneapolis, Minnesota; in the Platteville member of the Black River. No. 5113, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 57, fig. 5. (1897).

Fig. 3. *Gonioceras occidentale* Hall. Ventral view. Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 2861, Univ. of Michigan.

Fig. 4. *Gonioceras occidentale* Hall. Ventral view. Dixon, Illinois; in the Platteville member of the Black River formation. No. 46527, U. S. National Museum. Geol. Minnesota, *3*, pt. 2, pl. 57, fig. 6 (1897).

Fig. 5. *Spyroceras scofieldi* Foerste. A, lateral view, with supposed ventral outline on left; B, ventral view; living chamber projecting from larger end of endocone, the latter partially removed to expose the *Spyroceras*. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4118, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 53, fig. 4 (1897).

Fig. 6. *Tripteroceras planoconvexum* (Hall). Cross-section of conch, enlarged about 1.5 diameters, to show the flattening of the lateral sides and their dorsad convergence; also the flattening of the dorsolateral sides with the slight angulation of the median part of the dorsal side; with location of siphuncle. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 981, part of type series, American Museum of Naural History. See also plate 22, figs. 1 A, B, C.



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BLACK RIVER CEPHALOPODS

PLATE XXIV

Fig. 1. *Lambeoceras cf. nudum* Troedsson. One of the flattened sides, showing slight outward curvature of sutures of septa on approaching the lateral sides of the conch. Nettiling Lake, Southern Baffin Land; in the equivalent of the Red River formation. No. 6841, National Museum of Canada.

Fig. 2. *Lambeoceras confertum* Foerste. Ventral side of conch, showing one segment of the siphuncle. Stewartville, Minnesota; in the Stewartville dolomite. No. 8293 A, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2., pl. 56, fig. 2 (1897).

Fig. 3. *Metaspyroceras minneapolis* Foerste. A, lateral view, with ventral outline on left; B, dorsal view of another specimen. Minneapolis, Minnesota; in the Decorah member of the Black River formation. Nos. 381, 350, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, 786, pl. 54, figs. 7, 6 (1897).

Fig. 4. *Metaspyroceras rideauense* Foerste. A, ventral view; B, lateral view, with ventral outline on left. South of Ottawa, Ontario, Canada; on right bank of Rideau river, at Hog's Back; in the Chazyan. No. 6832, National Museum of Canada.

Fig. 5. *Metaspyroceras perlineatum* Foerste. A, dorsal side of conch; B, same side, showing the vertical striae, along upper part of conch. Ford plant, St. Paul, Minnesota; in the Decorah member of the Black River formation. No. 4130, Univ. of Minnesota.

Fig. 6. *Metaspyroceras wisconsinense* Foerste. Lateral view, with ventral outline on right. Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 8292, Univ. of Minnesota.

1

3A

2

3B

6

4A

5A

5B

4B

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PLATE XXV

Fig. 1. *Loganoceras regulare* (Billings). A, lateral view; B, dorsal view. Paquette Rapid, Allumette Island, Quebec, Canada; in the Leray member of the Black River formation. No. 1296, National Museum of Canada.

Fig. 2. *Loganoceras regulare* (Billings). A, lateral view; B, dorsal view. Paquette Rapid, Canada; in Black River formation. No. 1298 b, National Museum of Canada.

Fig. 3. *Manitoulinoceras* (?) *warsawense* Foerste. A, lateral view; B, dorsal view. Warsaw, Minnesota; in the Decorah member of the Black River formation. No. 4116, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, 809, pl. 59, figs. 16, 16a (1897).

Fig. 4. *Loganoceras massasaugaense* Foerste. A, lateral view, figured as though free from matrix; B, same, as actually imbedded in matrix; C, dorsal view. Massasauga Point, Bay of Quinte, near Belleville, Ontario, Canada; in the upper part of the Trenton. No. 7228, National Museum of Canada.

Fig. 5. *Loganoceras paquettense* Foerste. A, lateral view; B, ventral view showing trace of siphuncle; C, lateral view of second specimen, with septum at base. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 7229, National Museum of Canada.

Fig. 6. *Kentlandoceras wilsonae* Foerste. A, lateral view with ventral outline on right; B, ventral view; lower half of figure is a second fragment, supposed to belong to the same individual. Near Kingston, Ontario, Canada; in the Black River formation. No. 1271 b, d; in same tray with the lectotype of *Orthoceras drummondi* Billings, but evidently a slightly curved cyrtoceroid; National Museum of Canada.

Fig. 7. *Manitoulinoceras* (?) *wykoffense* Foerste. A, lateral view; B, ventral view showing siphuncle. Wykoff, Minnesota; in the Prosser member of the Trenton. No. 4117, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 59, figs. 17–19 (1897).

Fig. 8. *Manitoulinoceras* (?) *canadense* Foerste. A, lateral view; B, ventral view. In same tray with type of *Loganoceras regulare* (Billings), but lithologically resembling the rock from La Petite Chaudiere, near Ottawa, Ontario, Canada; in the Black River formation. No. 1296 a, National Museum of Canada.

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PLATE XXVI

Fig. 1. *Richardsonoceras simplex* (Billings). A, lateral view; B, ventral view. Nepean township, Carleton County, Ontario, Canada, lot N of concession A; in the Black River formation. No. 1303, National Museum of Canada. Holotype.

Fig. 2. *Richardsonoceras simplex* (Billings). Lateral view. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 13352, Univ. of Michigan.

Fig. 3. *Richardsonoceras simplex* (Billings). Lateral view. Lot 4 of concession 3, R.F., Gloucester township, Carleton county; in the Black River formation. No. 7393, National Museum of Canada.

Fig. 4. *Richardsonoceras simplex* (Billings). Lateral view. Lot 4, concession 3, R.F., Gloucester township, Carleton county; in the Black River formation. No. 7393 A, National Museum of Canada.

Fig. 5. *Richardsonoceras simplex* (Billings). A, lateral view; B, ventral side, showing part of siphuncle. Lot 4 of concession 3, R.F., Gloucester township, Carleton county; in the Black River formation. No. 7393 B, National Museum of Canada.

Fig. 6. *Richardsonoceras falx* (Billings). Lateral view. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 1298, National Museum of Canada. See also plate 7, figs. 1 A, B, C. Geol. Surv. Canada, Organic Remains, decade 1, pl. 7, fig. 1 (1859).

Fig. 7. *Richardsonoceras romingeri* Foerste. Lateral view. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 2460, Univ. of Michigan.

Fig. 8. *Richardsonoceras scofieldi* Foerste. A, lateral view; B, ventral view. Janesville, Wisconsin; in the Platteville member of the Black River formation. No. 4121, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 59, figs. 9–10 (1897).

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PLATE XXVII

Fig. 1. *Zitteloceras billingsi* (Salter). A, lateral view; B, ventral view. Paquette Rapid, Allumette Island, Ottawa river, Quebec, Canada; in the Leray member of the Black River formation. No. 1299a, National Museum of Canada. Geol. Surv. Canada, Canadian Organic Remains, dec. 1, pl. 7, fig. 6 (not. fig. 5) (1859).

Fig. 2. *Zitteloceras billingsi* (Salter). A, lateral view; B, ventral view. Paquette Rapid, Canada; in the Leray member of the Black River formation. No. 1299c, National Museum of Canada.

Fig. 3. *Zitteloceras brevicameratum* Foerste. Lateral view showing annulations and traces of several septa. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 2466, Univ. of Michigan.

Fig. 4. *Zitteloceras brevicameratum* Foerste. Lateral view showing sutures of septa. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 2866, Univ. of Michigan.

Fig. 5. *Laphamoceras scofieldi* Foerste. Lateral view, upper part showing inner wall of living chamber, lower part showing exterior of conch with transverse striae. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 207, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 60, fig. 10 (1987).

Fig. 6. *Zitteloceras clarkeanum* Foerste. A, lateral view of cast of interior of conch, retaining sinuate transverse striae of surface of shell and several sutures of septa; B, clay impression of cast of exterior, showing sutures of septa; C, same, oriented so as to show downward curvature of transverse striae at former locations of hyponomic sinus, at lower left margin of figure; D, natural cast of interior of conch showing downward curvature of transverse striae at former locations of hyponomic sinus along upper part of specimen, with a few sutures of septa along its lower portion. Janesville, Wisconsin; in the Platteville member of the Black River formation. No. 4120, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 60, figs. 11, 12 (1897).

Fig. 7. *Zitteloceras* (?) *sinuatum* (Billings). A, lateral view showing traces of the ventral parts of some of the septa; B, ventral view showing downward curvature of annulations at former locations of the hyponomic sinus. La Petite Chaudiere, near Ottawa, Ontario, Canada; in the Black River formation. No. 1302, National Museum of Canada.

Fig. 8. *Zitteloceras billingsi* (Salter). Lateral view, showing gerontic stage of growth. Paquette Rapid, Canada; in Leray member of Black River formation. No. 1299b, National Museum of Canada.

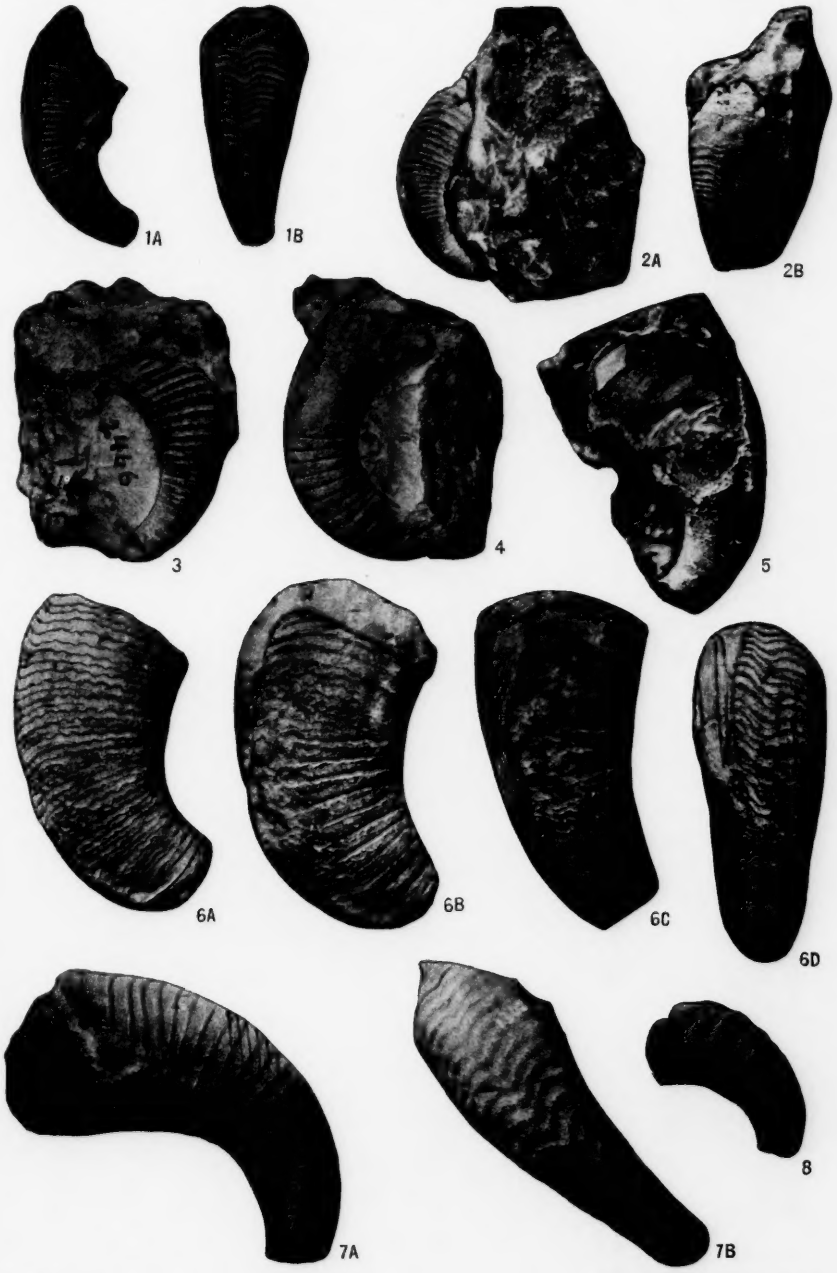

1A
1B
2A
2B
3
4
5
6A
6B
6C
6D
7A
7B
8

PLATE XXVIII

Fig. 1. *Centrocyrtoceras bondi* (Safford). Lateral view, showing intercalation of an occasional additional rib between the annulations, on the ventral side of the conch. Cliff on Stones River, west of Murfreesboro, Tennessee; in the Murfreesboro member of the Stones River division of the Chazyan. No. 87117 U. S. National Museum.

Fig. 2. *Centrocyrtoceras cf. subannulatum* (D'Orbigny). A, lateral view; B, same, enlarged to show the sinuous annulations. Paquette Rapid, Allumette Island, Ottawa River, Quebec, Canada; in the Leray member of the Black River formation, No. 6842, National Museum of Canada.

Fig. 3. *Centrocyrtoceras bondi* (Safford). A, ventral side; B, lateral view with short transverse ribs alternating with the annulations on the ventral side of the conch. Cannon county, Tennessee; in the Murfreesboro member of the Stones River division of the Chazyan. Museum of Vanderbilt University.

Fig. 4. *Centrocyrtoceras relaxum* Foerste. Lateral view, enlarged 1.5 diameters, with trace of a worm burrow at top. Murfreesboro, Tennessee; in the Murfreesboro member of the Stones River division of the Chazyan. No. 48409, U. S. National Museum.

Fig. 5. *Centrocyrtoceras ridleyense* Foerste. A, Specimen sectioned dorsoventrally to show the siphuncle; B, lateral view of another specimen, enlarged 1.5 diameters, to show the worm burrow on its lateral side; C, same specimen, natural size; D, holotype, enlarged, showing transverse annulations. Murfreesboro, Tennessee; in the Ridley member of the Stones River division of the Chazyan. No. 48408, U. S. National Museum.

Fig. 6. *Centrocyrtoceras vicinum* Foerste. A, lateral view, showing worm burrow, enlarged 1.5 diameters; B, opposite side of same specimen. Murfreesboro, Tennessee; in the Ridley member of the Stones River division of the Chazyan. No. 48406, U. S. National Museum.

Fig. 7. *Beloitoceras houghtoni* (Clarke). Lateral view. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4135, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 59, fig. 12 (1897). See also plate 30, fig. 9.

Fig. 8. *Centrocyrtoceras subannulatum* (D'Orbigny). A, lateral view with ventral outline on right; B, another specimen with ventral outline on left. Middleville, New York; in the Trenton formation. No. 821, Amer. Mus. Nat. Hist. Pal. New York, *1*, pl. 41, figs. 5, 4b, in the order here refigured (1847).

Fig. 9. *Centrocyrtoceras percinctum* Foerste. A, lateral view magnified; B, same, of natural size. Murfreesboro, Tennessee; in the Murfreesboro member of the Stones River division of the Chazyan. No. 48407, U. S. National Museum.

Fig. 10. *Paquettoceras allumettense* Foerste. Lateral view, with ventral side on right; upper part of specimen cut to expose the nearly central siphuncle. Paquette Rapid, Allumette Island, Ottawa River, Quebec, Canada; in the Leray member of the Black River formation. No. 7227, National Museum of Canada.

Fig. 11. *Centrocyrtoceras filosum* Foerste. A, lateral view showing fine striation; B, opposite side, magnified, showing worm burrow, Murfreesboro, Tennessee; in the Ridley member of the Stones River division of the Chazyan. No. 87036, U. S. National Museum.

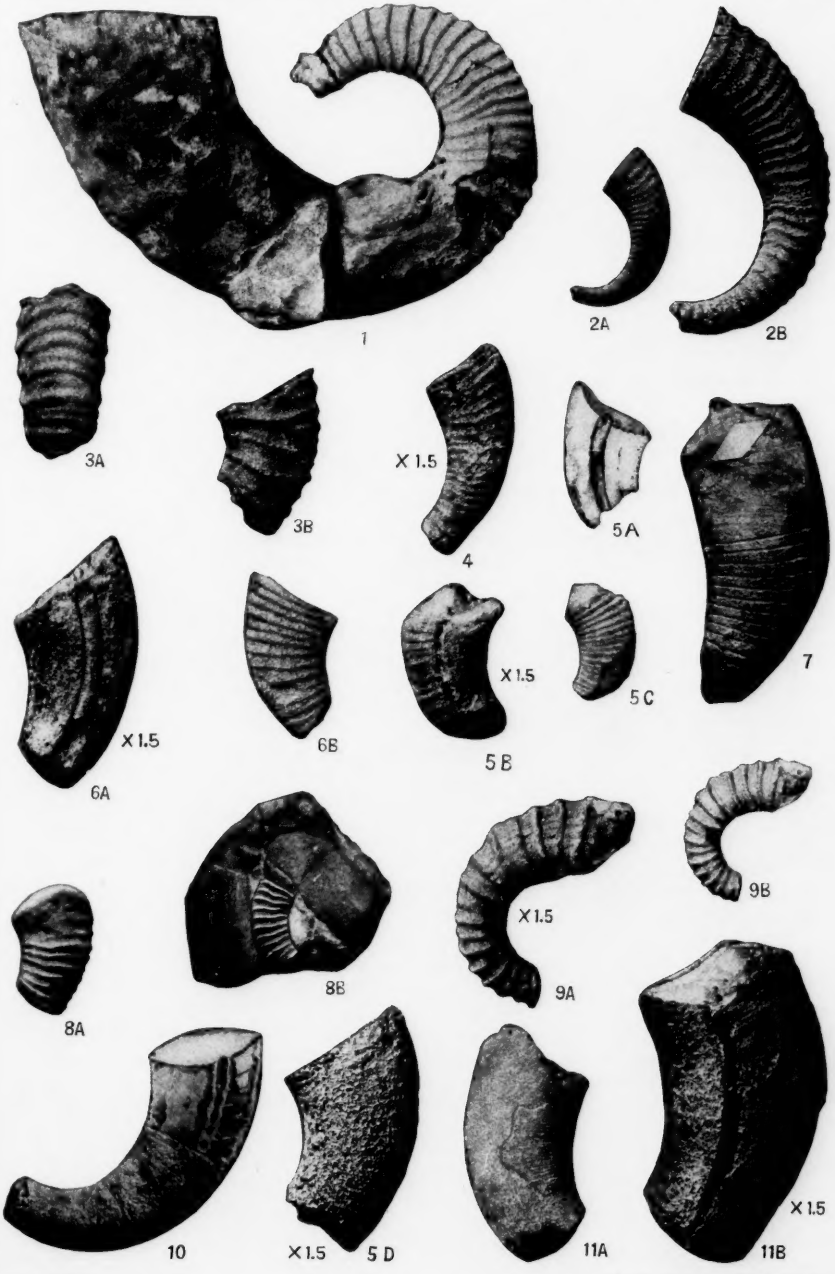

1
2A
2B
3A
3B
X 1.5
4
5A
7
6A
X 1.5
6B
X 1.5
5 B
5C
8A
8B
X 1.5
9A
9B
10
X 1.5
5 D
11A
X 1.5
11B

PLATE XXIX

Fig. 1. *Kentlandoceras husseyi* Foerste. A, ventral view of cast of interior of conch, showing vertical groove at extreme right and left of figure; B, lateral view with ventral outline on left, showing vertical groove slightly ventrad of median line of lateral side of conch. Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 14424, Univ. of Michigan.

Fig. 2. *Loganoceras* (?) *cf. paquettense* Foerste (possibly a Zitteloceras). A, lateral view; B, ventral view showing ventral margin of siphuncle. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 14471, Univ. of Michigan.

Fig. 3. *Orthoceras shideleri* Foerste. Supposed ventral side, showing vertical bands of color, slightly darker than remainder of shell. Five miles west of Oxford, Ohio, on Dodge creek; in the Saluda division of the Whitewater member of the Richmond. Collected by W. H. Shideler.

Fig. 4. *Cyrtorizoceras minneapolis* (Clarke). Cotypes. A, lateral view of one specimen, a living chamber; B, ventral view of same, with lateral sides converging at top; C, lateral view of second cotype; D, ventral view of same. Minneapolis, Minnesota; in the Platteville member of the Black River formation. No. 5048, 5066, Univ. Minnesota. Geol. of Minnesota, *3*, pt. 2, pl. 59, figs. 1–4, and figs. 5–6 respectively (1897).

Fig. 5. *Romingoceras josephianum* Foerste. Lateral view, shows low rate of enlargement of the conch. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 14485, Univ. of Michigan.

Fig. 6. *Staufferoceras featherstonhaughi* (Clarke). A, ventral view with glimpse of siphuncle; B, lateral view with ventral outline on right; C, dorsal view, showing relative flattening of this side. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4123, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 58, figs. 12–15 (1897).

Fig. 7. *Cyrtorizoceras minneapolis* (Clarke). Supposedly belonging to the same species as the cotypes illustrated in fig. 4, but enlarging less rapidly dorso-ventrally. A, lateral view, showing segment of siphuncle at its base; B, ventral view, with glimpses of the siphuncle. Minneapolis, Minnesota; in the Platteville member of the Black River formation. No. 46525, U. S. National Museum.

Fig. 8. *Probillingsites* sp. (Cornell). A, dorsal side; B, lateral view with dorsal side on right. Escanaba river, near Cornell, Michigan, at Hussey's locality 5, in zone 5; in the Trenton formation. No. 14459, Univ. of Michigan.

Fig. 9. *Ehlersoceras huronense* Foerste. A, lateral view, B, ventral view. St. Joseph Island, in the Black River formation. No. 8374, Univ. of Michigan.

Fig. 10. *Scofieldoceras* (?) *depressum* Foerste. A, dorsal view; B, lateral view. Warsaw, Minnesota; in the Decorah member of the Black River formation. No. 4133, Univ. of Minnesota.

Fig. 11. *Scofieldoceras shumardi* (Clarke). A, lateral view of living chamber with upper part of ventral outline geniculate; B, ventral view. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4134, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 60, figs. 1–4 (1897).

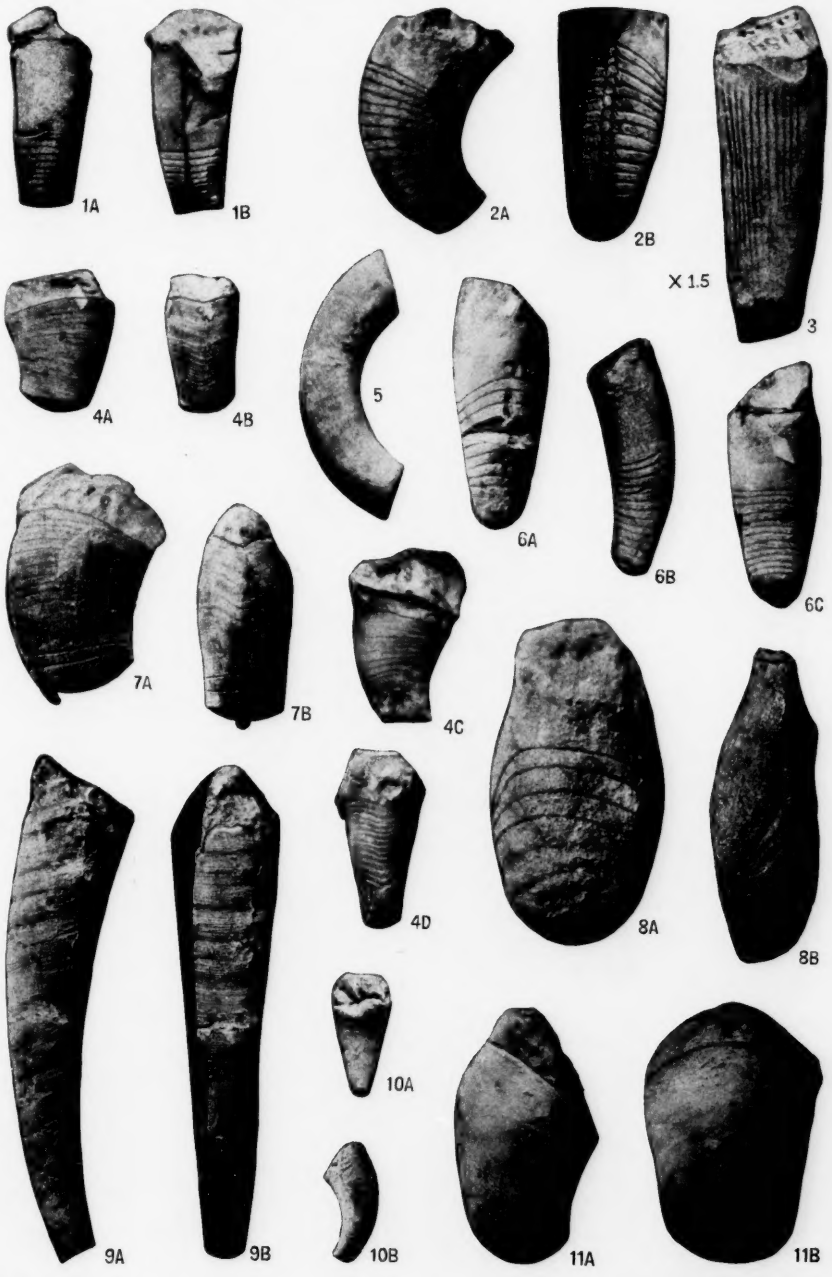

1A
1B
2A
2B
X 1.5
3
4A
4B
5
6A
6B
6C
7A
7B
4C
8A
8B
4D
9A
9B
10A
10B
11A
11B

PLATE XXX

Fig. 1. *Beloitoceras janesvillense* Foerste. A, lateral view; B, ventral view of same; C, ventral view of another specimen showing traces of siphuncle; D, lateral view of living chamber; E, ventral view of same. Janesville, Wisconsin; from the Platteville member of the Black River formation. No. 8300, Univ. of Minnesota. Geol. of Minnesota, *3*, pt. 2, pl. 58, figs. 5–6a (1897).

Fig. 2. *Beloitoceras isodorus* (Billings). A, lateral view, B, ventral view with siphuncle exposed along median line. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 1304, National Museum of Canada. Pal. Foss., Geol. Surv. Canada, p. 175, figs. 157a, b (1865).

Fig. 3. *Beloitoceras huronense* (Billings). A, lateral view; B, lateral view of another specimen; C, lateral view of third specimen weathered so as to show the septa. St. Joseph Island, Lake Huron, Canada; in the Black River formation. Nos. 1297b, 1297c, 1297, in the order here listed, National Museum of Canada. Pal. Foss., Geol. Surv. Canada, 176, figs. 158a, b (1865).

Fig. 4. *Beloitoceras cf. janesvillense* Foerste. Lateral view. Chatfield, Minnesota; in the Platteville member of the Black River formation, No. 8303, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 58, fig. 4 (1897).

Fig. 5. *Beloitoceras murrayi* Foerste. A, lateral view; B, ventral view with trace of siphuncle. St. Joseph Island, Lake Huron, Canada; in the Black River formation. No. 1297a, National Museum of Canada.

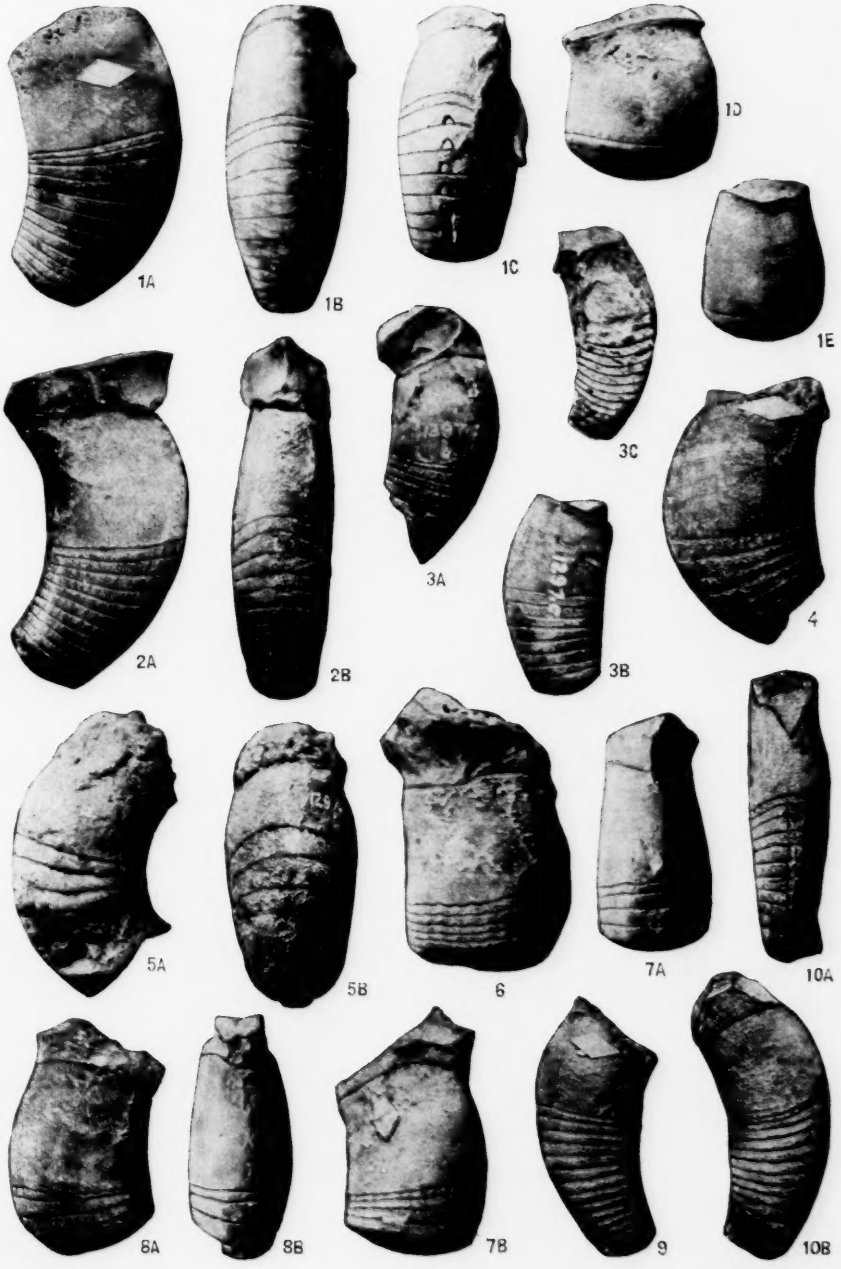
Fig. 6. *Beloitoceras norwoodi* (Clarke). Lateral view with ventral outline on right. Rockton, Illinois; in the Platteville member of the Black River formation, No. 4113, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 60, figs. 7–9 (1897).

Fig. 7. *Beloitoceras carveri* (Clarke). A, ventral view; B, lateral view with ventral outline on right. Minneapolis, Minnesota; in the Platteville member of the Black River formation. No. 8302, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 58, figs. 1–3 (1897), not the type of this species.

Fig. 8. *Beloitoceras carveri* (Clarke). A, lateral view; B, ventral view. Minneapolis, Minnesota; in the Black River formation. No. 2193, Univ. of Minnesota. Holotype. Geol. Minnesota, *3*, pt. 2, pl. 58, figs. 7–9 (1897).

Fig. 9. *Beloitoceras houghtoni* (Clarke). Lateral view. Cannon Falls, Minnesota; in the Platteville member of the Black River formation. No. 4135, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, plate 59, figs. 13–15 (1897). See also plate 22, fig. 7.

Fig. 10. *Beloitoceras houghtoni* (Clarke). A, ventral view; B, lateral view. Cannon Falls, Minnesota; in the Black River formation. No. M-C Univ. of Minnesota. Associated with the cotypes, but not previously figured.



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BLACK RIVER CEPHALOPODS

PLATE XXXI

Fig. 1. *Oncoceras collinsi* Foerste. A, dorsal view; B, lateral view with ventral outline on left. Lot 4, in concession 3, R. F., Gloucester township, Carleton county, Ontario, Canada; in the Black River formation. No. 7230, National Museum of Canada.

Fig. 2. *Oncoceras collinsi* Foerste. A, dorsal view; B, lateral view. Tetreauville, Quebec, along the Ottawa river; in the Black River formation. No. 6847, National Museum of Canada.

Fig. 3. *Oncoceras douglassi* (Clarke). A, lateral view with ventral outline on left, showing sutures of septa on right; B, dorsal view, showing sutures of septa. Hader, Minnesota; in the Prosser member of the Trenton formation. No. 243, Univ. of Minnesota, Geol. of Minnesota, *3*, pt. 2, pl. 60, figs. 13–15 (1897).

Fig. 4. *Oncoceras casei* Foerste. A, lateral view with dorsal side on left; B, dorsal view; C, same, enlarged to show the dark color markings arranged in diagonal rows. St. Joseph Island, Lake Huron, Ontario, Canada; in the Black River formation. No. 2458, Univ. of Michigan.

Fig. 5. *Wetherbyoceras vallandighami* (Miller). A, lateral view with ventral outline on left. Cincinnati, Ohio; in the Fairmount member of the Maysville formation. No. 48330, U. S. National Museum.

Fig. 6. *Fayettoceras thompsoni* (Miller). A, dorsal view; B, lateral view with ventral outline on right. Longwood, Fayette county, Indiana; from the Whitewater member of the Richmond. No. 64334, U. S. National Museum. 18th Ann. Rept. Indiana Dep. Geol. Nat. Res. pl. 10, figs. 7, 8 (1894).

Fig. 7. *Oncoceras tetreauvillense* Foerste. A, lateral view with ventral outline on right; B, ventral view. Tetreauville, Quebec, Canada, on the Ottawa river; In the Black River formation. No. 7394 National Museum of Canada.

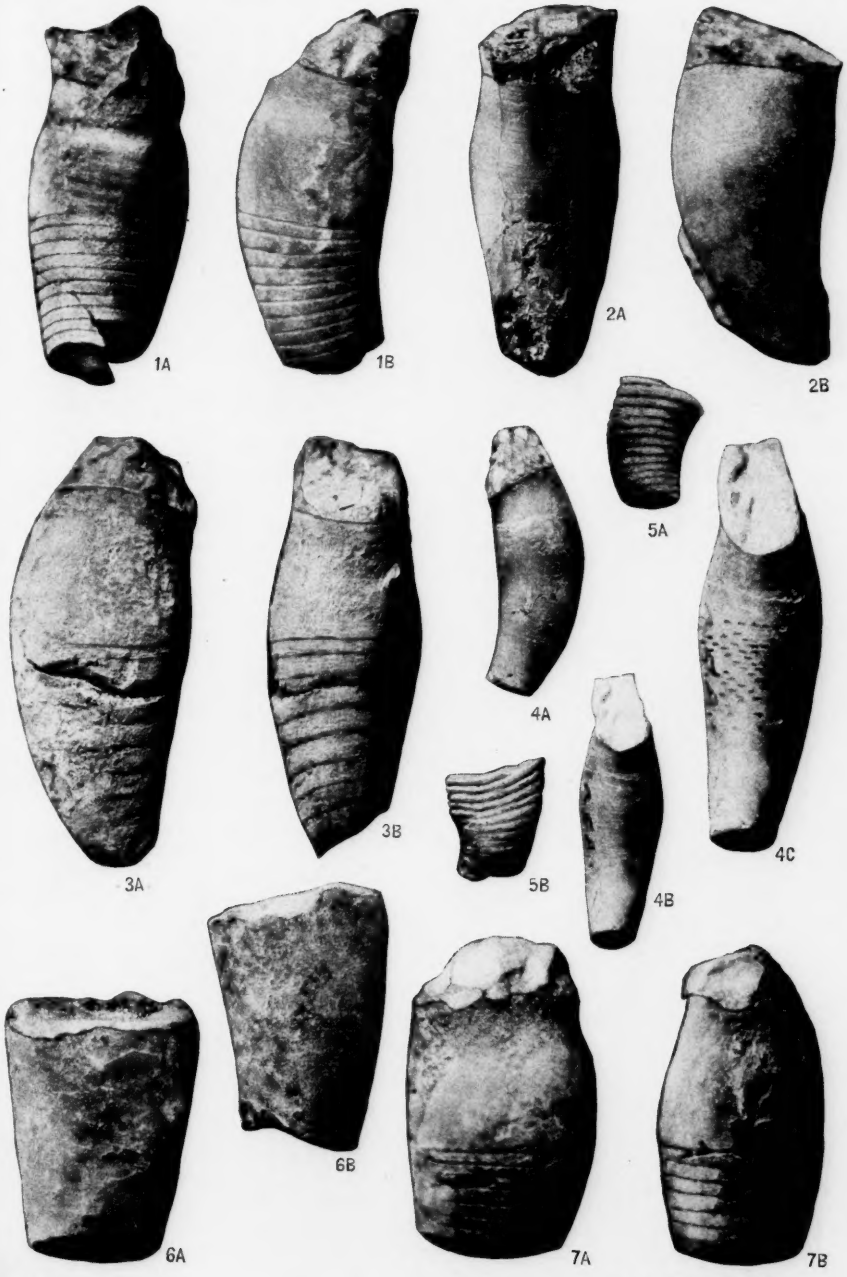

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PLATE XXXII

Fig. 1. *Whitfieldoceras mumiaforme* (Whitfield). A, dorsal view; B, lateral view with ventral outline on right. Tunnel 3 miles south of Belleville, Wisconsin; in the Platteville member of the Black River formation. No. 25320, U. S. National Museum.

Fig. 2. *Whitfieldoceras mumiaforme* (Whitfield). A, lateral view of living chamber with suture at base sloping in ventrad direction; B, similar lateral view. Mineral Point, Wisconsin; in the Platteville member of the Black River formation. No. 2830, Univ. of Michigan.

Fig. 3. *Whitfieldoceras mumiaforme* (Whitfield). Ventral side of living chamber. Janesville, Wisconsin; in the Platteville member of the Black River formation. No. 4125, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 57, fig. 7 (1897).

Fig. 4. *Whitfieldoceras mumiaforme* (Whitfield). Lateral view with ventral outline on right, showing siphuncle within cavity at base; living chamber only partially preserved. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 4127, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 57, fig. 10 (1897).

Fig. 5. *Whitfieldoceras clarkei* Foerste. Lateral view with ventral outline on right. Exact locality unknown, but apparently from upper part of Decorah member of the Black River formation, at some unknown locality in Minnesota. No. 4126, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 57, figs. 8, 9 (1897).

Fig. 6. *Whitfieldoceras trentonense* Foerste. Paratype; lateral view with ventral outline on right. Watertown, New York; in upper part of Trenton formation. No. 59493, U. S. National Museum.

Fig. 7. *Whitfieldoceras trentonense* Foerste. Holotype; A, lateral view with ventral outline on left; B, ventral view. Watertown, New York; in upper part of Trenton formation. No. 59492, U. S. National Museum.

Fig. 8. *Whitfieldoceras trentonense* Foerste. Lateral view, with ventral outline on right. Trenton Falls, New York; in the Trenton formation. No. 59494, U. S. National Museum.

Fig. 9. *Whitfieldoceras cf. exiguum* (Billings). A, ventral view of Clarke's fig. 10; B, lateral view of Clarke's fig. 11; C, lateral view of a third specimen; D, lateral view of a fourth specimen. Fountain, Minnesota; in the Trenton formation. Nos. 8281, 4114, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, pl. 58, figs. 10, 11 (1897).

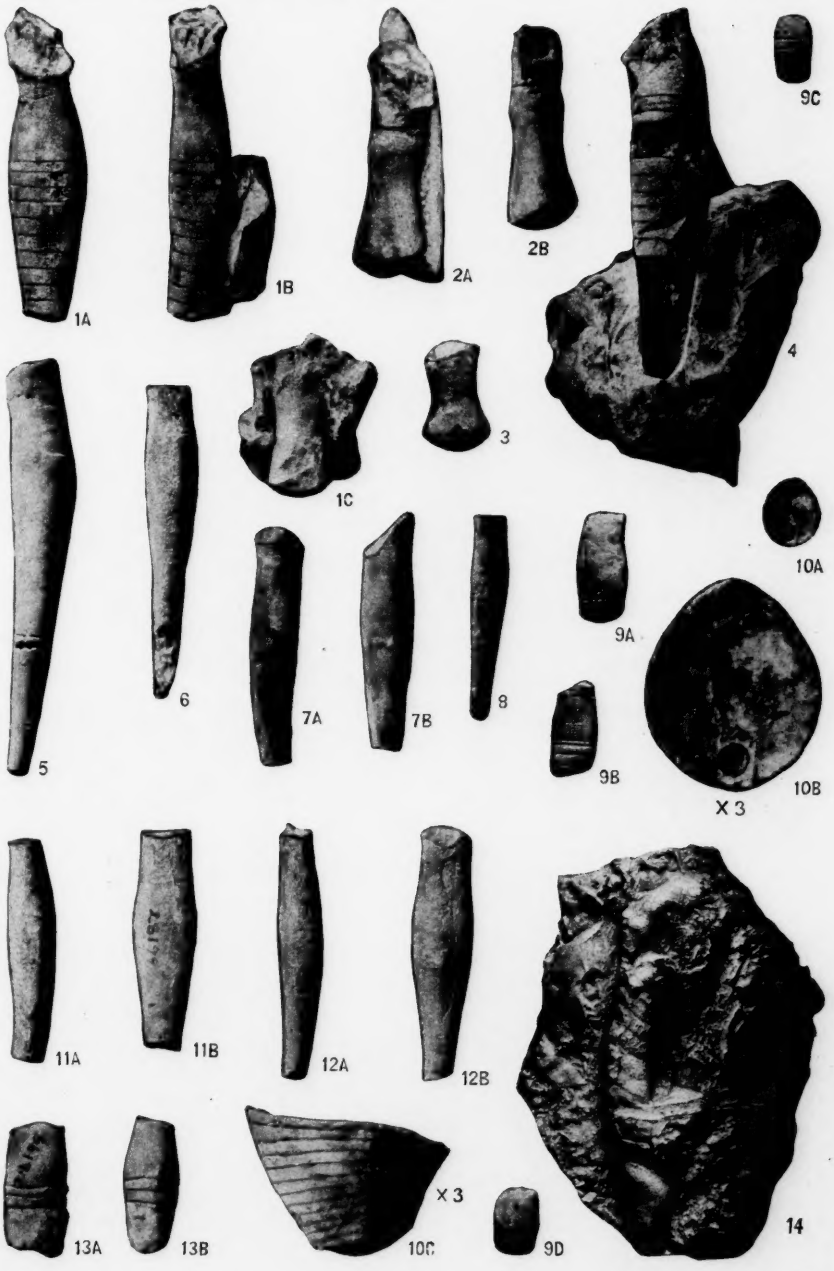
Fig. 10. *Cyrtocerina schoolcrafti* Clarke. A, viewed from above; B, same, enlarged; C, lateral view with siphuncle along concave margin on the right. Near Cannon Falls, Minnesota: in the Decorah member of the Black River formation. No. 46526, U. S. National Museum. Geol. of Minnesota, *3*, pt. 2, pl. 47, figs. 12–14 (1897).

Fig. 11. *Whitfieldoceras baffinense* Foerste. A, lateral view, with ventral outline on right; B, dorsal side. Head of Frobisher Bay, Baffin Land; in the Trenton. No. 28199 B, U. S. National Museum; cotype.

Fig. 12. *Whitfieldoceras baffinense* Foerste. A, lateral view with ventral outline on right; B, dorsal view. Head of Frobisher Bay, Baffin Land; in the Trenton. No. 28199 C, U. S. National Museum; cotype.

Fig. 13. *Whitfieldoceras baffinense* Foerste. A, dorsal view; B, lateral view with ventral outline on right. Head of Frobisher Bay, Baffin Land; in the Trenton. No. 28199 A; U. S. National Museum.

Fig. 14. *Nanno aulema* Clarke. Lateral view showing preseptal cone, three camerae, and lower part of siphuncle. Minneapolis, Minnesota; in the Decorah member of the Black River formation. No. 48198, U. S. National Museum; cotype. Geol. Minnesota, *3*, pt. 2, pl. 47, fig. 6, (1897).



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BLACK RIVER CEPHALOPODS

PLATE XXXIII

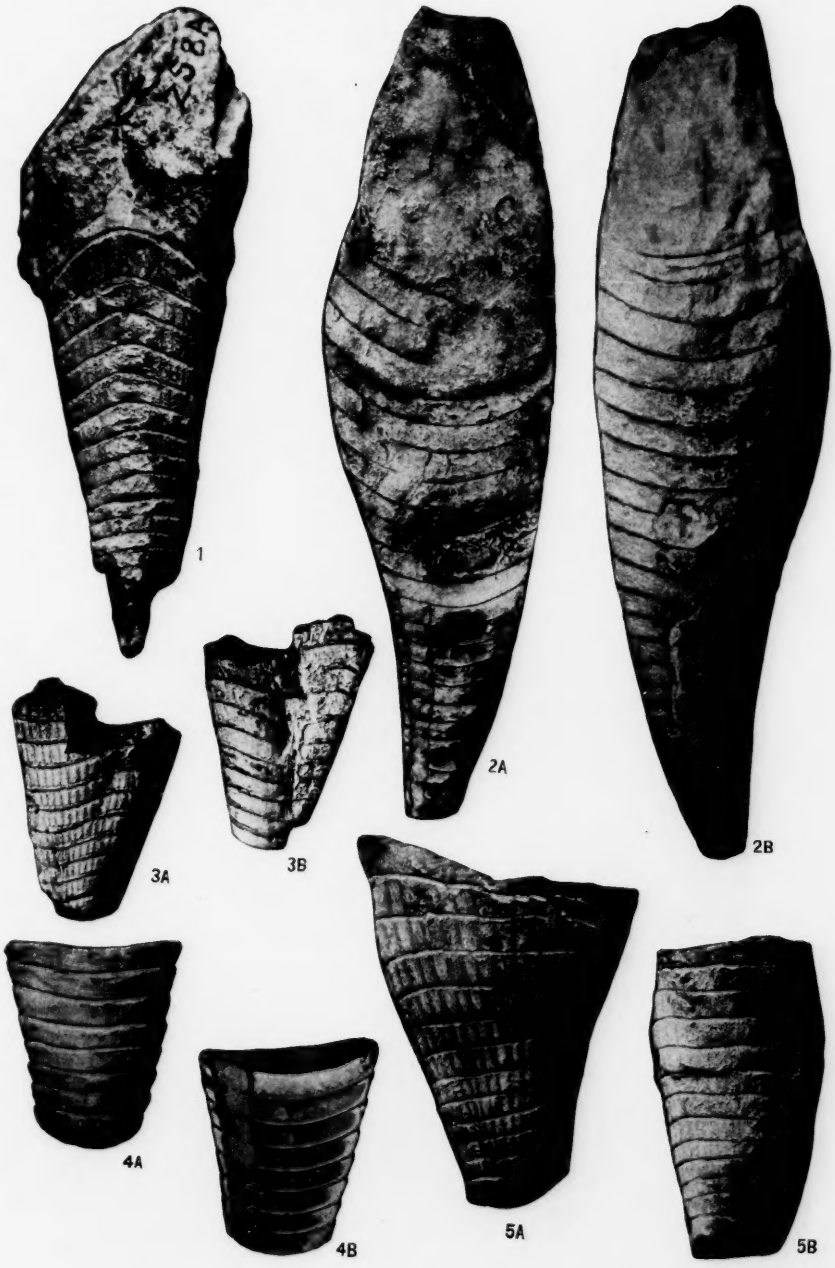
Fig. 1. *Westonoceras minnesotense* (Clarke). Ventral view. Lime City, Minnesota; listed from the upper part of the Prosser member of the Trenton formation, possibly from the Stewartville dolomite. No. 258a, Univ. of Minnesota, Geol. Minnesota, *3*, pt. 2, pl. 58, fig. 17 (1897).

Fig. 2. *Teichertoceras husseyi* Foerste. A, weathered side with traces of siphuncle on left; B, lateral view with siphuncular side on right, showing traces of vertical ribs on exterior of shell. Cornell, 13 miles northwest of Escanaba, Michigan; found on Escanaba river; at locality 5 of Hussey's section in the Trenton formation. No. 14461, Univ. of Michigan.

Fig. 3. *Westonoceras* (?) *ortoni* Meek. A, lateral view with ventral outline on left; B, lateral view with ventral outline on right. Cincinnati, Ohio; 200 feet above low water in Ohio river; in Southgate member of Eden formation. No. 48849, U. S. National Museum.

Fig. 4. *Teichertoceras* (?) *clarkei* Foerste. A, lateral view with siphuncular side on left; B, vertical section showing siphuncle; left outline of both specimens slightly concave. Possibly also from Lime City, Minnesota; and from the Stewartville dolomite. No. 258B, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, 799, fig. 10 (1897).

Fig. 5. *Westonoceras cf. minnesotense* (Clarke). A, lateral view with siphuncular side on left; B, dorsal view. Cornell, Michigan; on the Escanaba river, at locality 5, zone 6 of Hussey's section. No. 14483, Univ. of Michigan.



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BLACK RIVER CEPHALOPODS

PLATE XXXIV

Fig. 1. *Diestoceras staufferi* Foerste. A, lateral view with ventral outline on right; B, viewed from above, showing aperture with hyponomic sinus on upper margin as figured. Near Stone School, in district no. 142, Filmore county, Minnesota; in the Maquoketa member of the Richmond formation. No. 4099, Univ. of Minnesota.

Fig. 2. *Diestoceras romingeri* Foerste. A, dorsal view; B, lateral view with ventral outline on right. St. Joseph island, Lake Huron, Ontario, Canada; in the Black River formation. No. 2480, Univ. of Michigan.

Fig. 3. *Fayettoceras* (?) *beloitense* Foerste. A, lateral view with ventral outline on right; B, ventral view. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 15680, U. S. National Museum.

Fig. 4. *Rizoceras carletonense* Foerste. Ventral view, cut to show the siphuncle. In lot 4, concession 3, R. F., in Gloucester township, Carleton county, Ontario, Canada; southeast of Ottawa; in the Black River formation. No. 7390, National Museum of Canada.

1A

1B

3A

2A

2B

3B

4

PLATE XXXV

Fig. 1. *Centrocyrtoceras vagrans* (Billings). Holotype, sectioned to expose the structure of its interior, including apparently a glimpse of its siphuncle; coiling gyroceraconic. La Petite Chaudiere, on the Ottawa river, above Ottawa, Ontario, Quebec; in the Black River formation. No. 1300, National Museum of Canada. Geol. Surv. Canada, Pal. Foss., *3*, pt. 4, 311, pl. 40, figs. 1, 1a, 2, 2a (1906).

Fig. 2. *Centrocyrtoceras vagrans* (Billings). Badly weathered exterior of another specimen, showing its gyroceraconic form of coiling; the dorsal outline appears to extend as far as the lower part of the living chamber. La Petite Chaudiere, Ottawa, Canada; in the Black River formation. No. 1300a, National Museum of Canada.

Fig. 3. *Diestoceras cornellense* Foerste. A, ventral view; B, lateral side with ventral outline on right; the upper part of its dorsal side was crushed in by pressure subsequent to the death of the animal. Escanaba river, near Cornell, Michigan, at locality 5, zone 4 of Hussey's section. In the Trenton formation. No. 14416, Univ. of Michigan.

Fig. 4. *Geisonoceras drummondi* (Billings). A, living chamber with weak irregular annulations, including several camerae at its base; lateral view with ventral outline on right; B, dorsal view. Near Kingston, Ontario, Canada; in the Black River formation. No. 1271 National Museum of Canada. Pal. Foss., *1*, 173, fig. 156 (1865).

Fig. 5. *Geisonoceras drummondi* (Billings). A, assumed ventral side of an associated fragment which may belong to the same species as the type of *Geisonoceras drummondi* represented by fig. 4; B, lateral view of same with ventral side forming upper margin of figure; apparently curved lengthwise, no corresponding curvature being noted along the living chamber. Near Kingston, Ontario, Canada; in the Black River formation. No. 1271 a, National Museum of Canada.

Fig. 6. *Orthoceras beltrami* (Clarke). Lateral view of conch, apparently including the living chamber at the top. Wykoff Minnesota; in the Prosser member of the Trenton formation. No. 4122, Univ. of Minnesota. Geol. Minnesota, *3*, pt. 2, 789, pl. 55, fig. 10 (1897).

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PLATE XXXVI

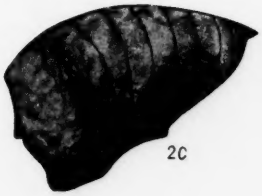
Fig. 1. *Plectoceras carletonense* Foerste. Lateral view of entire conch. In lot 4 of concession 3, R. F., Gloucester township, Carleton county, southeast of Ottawa, Canada; in the Black River formation. No. 7391, National Museum of Canada.

Fig. 2. *Plectoceras robertsoni* (Hall). A, the best preserved specimen among the cotypes studied by Hall, here selected as the holotype; B, lateral view of a smaller specimen; C, lateral view of a small fragment of the upper part of a phragmacone; D, living chamber with a single camera attached at its base. Figures A and B are based on cotypes from Rockford, Illinois, in the Platteville member of the Black River formation; Figures C, and D, on two other cotypes in the Hall collection, from the same horizon. No. 1003, Amer. Mus. Nat. Hist. Whitfield, Mem. Amer. Mus. Nat. Hist., *1*, pt. 2, 64, pl. 10, figs. 4–6 (1895).

Fig. 3. *Plectoceras robertsoni* (Hall). A, lateral view of conch, represented in part by the impression of its opposite side in the matrix; B, lateral view of upper part of phragmacone, showing the transverse ribs, becoming obsolete dorsolaterally. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 3685, 14466, Univ. of Michigan.

1

2D



2C

2B

3B

3A

2A

PLATE XXXVII

Fig. 1. *Ormoceras husseyi* Foerste. A, weathered side of conch exposing glimpses of the siphuncle at two places, cut along lower left margin to show the structure of the interior of this siphuncle; B, structure of siphuncle as shown by preceding specimen. Ford River, northern peninsula of Michigan, west of Escanaba; in the Trenton formation. No. 14465, Univ. of Michigan.

Fig. 2. *Kionoceras paquettense* Foerste. A, lateral view, faintly convex along left or ventral margin; B, same, enlarged. Paquette Rapid, Allumette Island, Ottawa river, province of Quebec, Canada; in the Leray member of the Black River formation. No. 6827, National Museum of Canada.

Fig. 3. *Richardsonoceras beloitense* Foerste. A, lateral view with ventral outline on left; B, ventral view, with subangular cross-section, showing corresponding subangular ventral saddles of the sutures of the septa; C, lateral view of another specimen, showing segments of the sipuncle; D, ventral view of this second specimen. Samp quarry, Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 4115, Univ. of Minnesota.

Fig. 4. *Beloitoceras clochense* Foerste. Lateral view showing crests of lateral parts of aperture, with a deep ventral hyponomic sinus. Cloche Island, north of eastern part of Manitoulin Island, in northwestern part of Lake Huron, Ontario, Canada; in the Black River formation. No. 1294, National Museum of Canada. Canadian Nat. Geol., *5*, fig. 20 (not fig. 19) (1860).

Fig. 5. *Richardsonoceras (?) clarkei* Foerste. A, ventral view with glimpses of siphuncle a little above mid-length; B, lateral view of same specimen, with ventral outline on right. Beloit, Wisconsin; in the Platteville member of the Black River formation. No. 4136, Univ. of Minnesota. Original of *Cyrtoceras neleus* Clarke, Geol. Minnesota, *3*, pt. 2, 804, pl. 59, fig. 20 (1897).

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BLACK RIVER CEPHALOPODS

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